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Regional Agricultural Trade and Changing Comparative Advantage in South Africa

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Contents

Foreword

Southern Africa was characterized by a heavy regulated agricultural market before the late 1980s, but since then countries in the region followed a strategy to remove restrictive measures from its agriculture. The deregulation process was also accompanied by the liberalization of agriculture worldwide. South Africa, just as the whole southern African region, will have to compete internationally in a more open agricultural market. In order to be competitive southern African countries will have to use resources more efficiently by exploiting comparative advantages that may exist. This, among other things, entails that policy and decision-makers should be guided so as to implement policies and strategies that will enhance agricultural producers competitiveness.

Various studies have shown that countries can improve their welfare by opening up their borders to freer trade. There is furthermore a worldwide move toward economic integration. Southern Africa is no exception to the rule with the movement toward a Free Trade Area under the auspices of the Southern African Development Community (SADC). Not only is it foreseen that this movement will improve welfare in the whole region, but the region's competitiveness may also improve. Within the framework of economic integration in southern Africa countries in the region will reap the benefits by exploiting comparative advantages that may exist.

South Africa is one of seven countries in the SADC participating in the Research Program on Regional Agricultural Trade and Changing Comparative Advantage in Southern Africa. The comparative economic analysis (CEA) study in South Africa therefore forms part of a larger activity to determine comparative advantages in the region. These studies not only examine the existing comparative advantages, but also provide a means to evaluate the impact of different agricultural policies on comparative advantage. This proves to be an especially valuable tool to guide policymakers in the region. This study provided insight into which factors contribute the most to market distortions in South Africa. These are mainly policies that distort market prices, the exchange rate, and tariffs and subsidies on inputs. This study also made a significant contribution toward establishing the affect of water legislation on the South African agriculture.

This study is one in a series of studies on Africa's regional trade and comparative advantage, a joint activity of USAID Africa's Bureau's in the Office of Sustainable Development, Productive Sector Growth and Environment Division and the Regional Economic Development Services Office for Eastern and Southern Africa (REDSO/ESA).

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Dedication

Dedicated to the memory of the late Professor Glenn Themba Magagula, formerly Deputy Vice Chancellor of the University of Swaziland, whose vision, foresight and leadership led to the development and implementation of the “Regional Trade and Comparative Economic Advantage in Southern Africa” activity.

Executive Summary

South Africa is one of seven countries in the Southern African Development Community (SADC) participating in the Research Program on Regional Agricultural Trade and Changing Comparative Advantage in Southern Africa. Comparative economic advantage (CEA) analysis is the first step in generating information and analysis that will inform and guide policy design in the region to exploit CEA and allocate resources to their most productive uses.

In order to keep the study manageable, the study was limited in the following manner: (1) only certain products/commodities were selected for analysis, namely maize, wheat, potatoes, sunflowers, cotton, sorghum, soybeans, tobacco, beef and mutton; (2) cultivation practices were limited to irrigation and rain-fed (dryland) production for all the crops, while for beef and maize large-scale and small-scale production systems were also distinguished; (3) data for the 1994-95 production season were used for all budgets and the subsequent analysis; and (4) South Africa was divided into only six agro-ecological zones.

Data on the commercial farming sector is gathered and processed annually by the National Department of Agriculture located in Pretoria. The data used for different commodities in this study were mainly derived from these sources. Cross verification was done by means of information received from the different agricultural Marketing Boards, consultants and regional extension officers. Only limited data on subsistence farming areas are available from publications. For this reason, the Departments of Agricultural Economics at the University of Pretoria and the University of Natal engaged in a project aimed to establish enterprise data for small-scale farming. Macroeconomic data was obtained from the South African Reserve Bank, various international publications and private companies. Data used to determine the different agro-ecological zones for South Africa used in this study were obtained from various sources, including maps and GIS information generated by the Departments of Landscape Architecture and also Soil Science at the University of Pretoria.

The final report has the following outline: Chapter 1 provides the introduction to the study. Chapter 2 presents a discussion of the South African agricultural economy and the different commodities to be examined. In Chapter 3, the methodology followed is explained. Different agro-ecological zones are determined in Chapter 4. In Chapter 5, the private and social profitability, as well as domestic resource costs (DRC), of different commodities within different agro-economical zones are evaluated. Chapter 6 comprises a sensitivity analysis. Chapter 7 consists of a summary and conclusions.

RESULTS AND CONCLUSIONS

General

Different factors contributed to market distortions within South African agriculture. These distortions caused scarce resources to be used sub-optimally. Although it is not the aim of this study to quantify the welfare effect of the non-optimal use of scarce resources, it can be concluded that the non-optimal use of resources had a negative effect on the welfare of farmers. This is clearly illustrated by the larger economic rather than private returns for many commodities. While the NPE and EPR results indicate the existence of market distortions in the market for the products investigated. Three main factors contributed to the market distortions, namely: (1) distortions in product prices, mainly due to the statutory powers of the different Marketing Boards; (2) the exchange rate; and (3) tariffs and subsidies levied on inputs. The first two of these contributed the most to distortions in the market, while the latter's contribution amounted to less than 15 percent.

The DRC methodology was used in this study to determine the comparative advantages of different products in different zones. The comparative advantages need to be exploited by farmers and the right incentives need to be given by the government to farmers to pursue this end. The comparative advantages calculated are based on the returns to land and water. This essentially means that policies such as the new Water Act will have a definite impact on the usage of water. In Zones 1, 3, 4, 5 and 6, crops under irrigation have comparative advantages over other crops cultivated in those zones. Increasing the cost of water may have an influence on the comparative advantage a crop may hold.

It is also important to take into account the climate, biological and physical constraints in each zone when evaluating comparative advantages for different zones. A crop may have a comparative advantage over other crops, but due to climate, biological and physical constraints can not be produced throughout that zone. In this situation, the second best option must be identified. The distance from markets must also be considered. Transport cost plays an increasingly important role in the competitiveness of agricultural producers. Producers may have comparative advantage in producing a product in a specific region, but due to transport costs it may not be profitable to produce that crop.

Land and Water

Policies regarding land and water will have a major influence on the comparative advantage South Africa may have vis-à-vis the production of agricultural products in other countries. These policies should be considered against this background. Not only will policies on land and water influence comparative advantage between countries, but also between regions in South Africa. One should expect changes in resource use if water tariffs in South Africa are inclusive of its scarcity value. The change in production patterns that can be expected if the latter is implemented will differ between regions. It may be relatively easy to substitute seasonal crops with each other, but this will not be the case with long term crops, such as sub-tropical fruits and citrus. In summary, the analyses show the following general results: (1) water cost will influence the competitiveness of dryland production in relation to irrigation production; (2) the amount of water used will in future influence the competitiveness of production; (3) dryland production practices may in some instances be more advantageous than irrigation production practices; and (4) the intensity of water use may cause one crop to lose its comparative advantage to another crop.

Other Issues

Other factors that should be considered are demand and supply forces domestically and internationally. Although a crop may hold a comparative advantage over other crops, unlimited production will cause prices to drop and thus erode its comparative advantage. The balance between demand, supply and the association with regard to comparative advantage is not clear. The development of a general equilibrium model that incorporates resource endowments and supply and demand forces is necessary to get a better understanding of these forces. Such a model will give policy makers the tools to base policies on.

Glossary of Acronyms and Abbreviations

AEZ	Agro-Ecological Zones
BPP	Buying Power Parity
CEA	Comparative Economic Advantage
CDRS	Cost of Domestic Resources
CIF	Cost Insurance Freight
CSS	Central Statistical Service
DBSA	Development bank for South Africa
DRC	Domestic Resource Costs
EPC	Effective Policy Coefficient
EPR	Effective Protection Ratio
FOB	Free on Board
FSP	Farmer Support Program
FTA	Free Trade Area
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GNP	Gross National Product
IDC	Industrial Development Corporation
MPS	Market Price Support
MSL	Minimum Subsistence Level
NDA	National Department of Agriculture
NFI	Net Farm Income
NPE	Net Policy Effect
NPR	Nominal Protection Ratio
PSE	Producer Subsidy Equivalent
RCR	Resource Cost Ratio
RSA	Republic of South Africa
SADC	Southern African Developement Community
SARB	South African Reserve Bank
TFP	Total Factor Productivity
WTO	World Trade Organization

1. Introduction

"I think of international trade as the most complicated of all fields in economics. It must deal, not only with problems peculiar to exchange between countries, but with all of the problems encountered in economic analysis on a lesser scale."

– Bawden, 1966

1.1 BACKGROUND

South Africa is one of seven countries in the Southern African Development Community (SADC) participating in the Research Program on Regional Agricultural Trade and Changing Comparative Advantage in Southern Africa. This analysis is particularly important for South Africa in the view of its newly found status in southern Africa, mostly due to favorable political developments, including the democratic elections in 1994. As South Africa moves towards a new post-apartheid democratic society, the way is opened for new/renewed trade, investment, transport and communication linkages among southern and eastern African countries.

Taken separately, many member states of the SADC are characterized by small developing economies that are unable to provide adequate employment, goods and services to citizens. Only a limited number of these countries are able to compete successfully in the global marketplace with a wide range of commodities and their exports remain vulnerable to fluctuations in world prices. Although the region is relatively poor with respect to human and other capital, it is rich in natural resources and human resources. Therefore, the countries of southern Africa collectively have the potential to become a powerful economic bloc. This can be achieved by pooling resources and capitalising on each other's comparative advantages (SADC, 1994). This implies a central role for trade within southern Africa, as well as trade between the region and the rest of the world in future.

More than ever, economists now agree that gains from trade are a key source of national wealth, and that faster growth can be achieved by pursuing activities with greater comparative economic advantages. This applies particularly to the agricultural sector, where attempts to "go against" comparative advantage have been both widespread and costly (Masters, 1995).

Comparative advantages that exist in the southern African region, will be the basis from which intra-regional trade will take place. All the countries stand to benefit from intra- regional trade. Countries in the region will, under a Free Trade Area (FTA), be able to export primary agricultural products to the more lucrative South African market. This will in turn impact on South African agricultural producers, since competition from the region will increase. South Africa, on the other hand, will be afforded the opportunity to increase its trade in value-added agricultural and industrial products to other countries in the region. These markets are currently not being used to their full potential, mainly due to a lack of market infrastructure and buying power. The region as a whole stands to benefit from the transfer of investment and technology from South Africa to other southern African countries. There is already great interest in investing in agricultural processing plants in countries outside South Africa. This will create employment opportunities and generally contribute to the welfare of people in the region.

It is furthermore known that some countries in the region, other than South Africa, suffer from a lack of infrastructure. With regional integration, these countries will have access to infrastructure in South Africa. More importantly, however, infrastructure can be transferred or extended throughout the region. Through investment and the creation of infrastructure, access to markets will become easier. This will enable producers of agricultural products to react to market signals. The result will be a major increase in trade

within the region, based on comparative advantages. It is therefore of the utmost importance for individual countries to analyze opportunities for regional trade. Each country will have to consider changes in direction and pattern of trade, since it will influence the use of the natural resource base in that country. One can also expect structural changes to take place that will have important implications for regional and household food security.

1.2 OBJECTIVES

Comparative economic advantage (CEA) analysis is the first step in generating information and analysis that will inform and guide policy design in the region to exploit CEA and allocate resources to their most productive uses. Therefore, under the overall objectives of the Regional Trade Project, this study aims to achieve the following specific objectives:

- evaluate the CEA of alternative agricultural production activities in the various agro-ecological zones and under different technology levels and land tenure systems in South Africa;
- analyse the potential impacts of removing existing price and policy distortions on the economic efficiency of alternative productive uses of the South Africa's resources;
- identify points of policy, technology, and institutional intervention to enhance economic efficiency and direct agricultural resources to their most productive uses; and
- build the South African country data componentneeded for conducting the regional analysis of CEA and trade in agricultural commodities for southern Africa.

1.3 RESEARCH METHODOLOGY

In order to exploit existing and potential trade opportunities efficiently, comparative advantage principles should guide economic policy reforms to direct resources to their most productive use. Comparative economic advantage (CEA) analysis is the most common criterion used to evaluate economic efficiency in terms of social welfare gains from feasible alternative production options. The first step is to identify existing and potential opportunities for trade, that is options and activities of highest economic efficiency in the countries forming a potential trading bloc need to be examined and identified (Hassan and D'Silva, 1994).

According to Hassan and Faki (1993), the Domestic Resource Cost (DRC) methodology provides the analytical tool for an empirical evaluation of economic efficiency among alternative enterprises. It is a commonly used criteria for measuring CEA. The concept of DRC relates to a measure of real opportunity cost in terms of total domestic resources of producing (or saving) a net marginal unit of foreign exchange (Bruno, 1967). The DRC method generates several measures of relative economic efficiency of production alternatives. It is used as an *ex ante* measure of comparative advantage to determine which among a set of alternative production activities is relatively efficient for a country or region in terms of contribution to national income (Bruno, 1967).

Hassan and D'Silva (1994) investigated the reasons for the importance of conducting CEA analysis within an agro-ecological framework. They concluded that agricultural production is primarily a biological process that is highly dependant on the prevailing biophysical conditions. Agricultural suitability reveals the similarity in natural resource endowments and production potential, and hence complimentarity or competitiveness in trade, between countries.

In this study, DRC measures of CEA will be calculated for various commodity groupings in order to capture and analyse the impacts of the above-mentioned determinants. The following conventions will be adopted to group commodities according to the above factors:

- As recommended by the Regional Trade Project's Steering Committee at the June 1995 meeting in Pretoria, the agro-ecological zonation approach will be adopted as the framework for classifying

production environments according to biophysical conditions.

- Variations within agro-ecological zones (AEZ), due to variations in technology, tenure, etc., will be captured by coding different production systems as distinct activities.
- Variations in market and infrastructural factors will be reflected in prices and transportation costs. These variations will be captured by defining a central market node for every zone at which all trade will be assumed to take place. Consequently, prices and transport costs between these market centers (nodes) will reflect the opportunity cost of producing a commodity locally versus importing it from another region/zone or from outside the country.
- Variations in resource endowments will be reflected in the relative rental values of those resources in the different market centers.

1.4 DELIMITATION OF THE STUDY

In order to keep the study manageable, and following the suggestions of the Steering Committee of the Research Program on Regional Agricultural Trade and Changing Comparative Advantage in Southern Africa, it was decided to limit the analysis in the following manner:

- Only certain products/commodities were selected for analysis, namely maize, wheat, potatoes, sunflowers, cotton, sorghum, soybeans, tobacco, beef and mutton;
- cultivation practices were limited to irrigation and rain-fed (dryland) production for all the crops (with the exception of tobacco, which is only produced under irrigation), while for beef, large-scale and small-scale production systems were distinguished;
- data for the 1994/95 production season were used for all budgets and the subsequent analysis; and
- South Africa was divided into only a limited number of agro-ecological zones (six in total).

1.5 DATA USED

South Africa's agricultural sector consists mainly of commercial farming units. More than 80 percent of all agricultural land is farmed commercially. Data on the commercial farming sector are gathered and processed annually by the National Department of Agriculture located in Pretoria. These data include production, supply, stocks and price information on different agricultural products that are published in the *Abstract of Agricultural Statistics* (NDA, 1996). Data pertaining to commercial enterprise budgets for different agricultural products are gathered on a regional basis by the provincial Departments of Agriculture, and is published annually in the *COMBUD Reports* (COMBUD, 1994). The data used for different products in this study were mainly derived from these publications. For this reason, no wide-ranging survey of actual cultivation practices was done to gather information pertaining to commercial enterprise budgets. Cross verification of prices, yields, etc., was done by means of information received from the different agricultural Marketing Boards, consultants and regional extension officers. The process used for compiling the detailed crop and livestock budgets entailed the following steps:

- comparison of different budgets for a specific enterprise within a particular zone;
- use of secondary farm survey data and agricultural statistics to compile a single, detailed budget for the specific enterprise and zone;
- discussions with extension officers and crop/livestock scientists working in the particular zone to ensure realism in the different budgets; and
- meetings with groups of representative farmers in each zone (10-12 farmers) to verify and fine-tune the budgets.

Macroeconomic data with regard to exchange rates, producer price indexes, international prices and transport cost were obtained from the South African

Reserve Bank, various international publications, commercial banks and Spoornet. Data used to determine the different agro-ecological zones for South Africa used in this study were obtained from various sources, including maps and GIS information generated by the Departments of Landscape Architecture and also Soil Science at the University of Pretoria.

In South Africa, only limited data on subsistence farming areas available through publications, mainly from the Development Bank of Southern Africa and the various regional development corporations. For this reason, the Departments of Agricultural Economics at the University of Pretoria and the University of Natal engaged in a project aimed to establish enterprise data for small-scale farming. Information from this study was used to construct enterprise budgets for the small-scale farming sector.

1.6 OUTLINE OF THE STUDY

Chapter 1 provides the introduction to the study, with sections on the background, objectives, methodology, delimitation, data and outline. Chapter 2 presents a discussion of the South African agricultural economy and the different products to be examined. This chapter serves as a background for the rest of the study, particularly identifying sources of possible distortions due to specific policies followed. In Chapter 3, the methodology followed is explained, followed by the different approaches employed to determine private and social profitability for the different products in the study. Different agro-ecological zones, which are used as a benchmark for identifying comparative advantage in South Africa, are determined in Chapter 4. In Chapter 5, the private and social profitability of different products within different agro-economical zones are evaluated. This is followed by measures of comparative advantage of each zone. Chapter 6 comprises a sensitivity analysis. The final chapter, Chapter 7, consists of a summary and some conclusions.

2. Overview of the South African Agricultural Economy: Structure, Policies and Commodities

2.1 INTRODUCTION

This chapter provides an overview of South African agriculture. It consists of three distinct sections. First, it briefly describes the structure of South African agriculture. Second, it gives a summary of agricultural policies, changes in policy and their effects. This is particularly important, as it provides insight into the distortions within the South African economy, which are part of the motivation for DRC analysis used in this study. Third, it provides a brief discussion of the specific commodities analysed in this study. This chapter only serves as background for the analysis of comparative advantage as it gives the context within agricultural production takes place.

2.2 THE STRUCTURE OF THE SOUTH AFRICAN AGRICULTURE

The Republic of South Africa covers an area of 1.2 million square kilometers. Approximately 84 percent of the total area is used for agriculture and forestry, of which approximately 80 percent consists of natural grazing. This varies from semi-desert vegetation to the highly productive grasslands of the high rainfall areas (Department of Agriculture, 1989). In comparison with other countries, South Africa has very little high quality arable land (15.8 million hectares) of which 1.29 million hectares are under irrigation.

Great pressure on the per capita arable and irrigation land is being placed by the population growth in South Africa. It is estimated that land area available per person in South Africa will fall to a mere 1.5 hectares in the year 2000 from 5.5 hectares in 1970 (Van Zyl and Van Rooyen, 1991). Potential arable land is furthermore increasingly being utilized for non-agricultural purposes.

In terms of physical and biological norms, South Africa can be described as relatively poor in natural agricultural resources. South Africa has three main rainfall regions: a winter rainfall area in the south-western corner of the country; an all-year rainfall area along the southern coast region; and a summer rainfall region area over the remainder of the country. The average rainfall from 1990 to 1994 was 448 millimeters per annum (Weather Bureau, 1995). Only about 10 percent of the country receives more than 750 millimeters per annum, while approximately 21 percent of the country receives less than 200 millimeters of rain per annum (World Bank, 1994). Clearly, there is great variation in both rainfall and runoff. Still, with all this in mind, South Africa produces a wide variety of agricultural crops, which are largely determined by the seasonal distribution of rainfall. These aspects are pursued further in more detail in Chapter 5 of this study.

Of all the countries in southern Africa, South Africa is the best developed with respect to human capital, infrastructure and industry (Sartorius von Bach and Van Rooyen, 1995). South Africa can therefore play a very important role in regional integration and can contribute to the welfare of the whole of southern Africa. Although South Africa produces surpluses of staple foods such as maize, it is not self-sufficient in certain meat products. It is therefore clear that regional trade in agricultural products can be mutually beneficial.

South Africa has a population of approximately 40 million people (DBSA, 1995a). This is about 23 times that of countries like Botswana and Namibia combined. The demand for food and the use of resources are thus very high in comparison to other southern African countries.

Table 2.1. Gross Value of Agricultural Production (R million)

	Field Crops		Horticultural Products		Animal products		Total
Years	Rand million	% contrib.	Rand million	% contrib.	Rand million	% contrib.	Rand million
1960/61	6,289.70	42.63	2,163.80	14.67	6,298.30	42.70	14,751.80
1975/76	9,527.50	41.74	4,005.30	17.54	9,296.20	40.72	22,829.00
1993/94	6,110.10	35.85	3,615.60	21.21	7,317.80	42.94	17,043.50

Source: NDA (1995)

The agricultural sector's contribution to the GDP declined from 21 percent in 1911 to 4.6 percent in 1993 (CSS, 1995a). This downward trend does not indicate an absolute decline in the economic importance of the sector, but it should rather be partly attributed to the general growth in the economy. Agriculture's contribution to GDP tends to conceal its true value to the economy. Agriculture's importance in provision of food, employment, etc. must also be emphasised. Moreover, Van Zyl et al (1988) state that an important consideration to be taken into account is that the overall impact of a change in agricultural production, for example as a result of drought, is almost twice as great as its direct impact on the rest of the economy. Obviously, there exists considerable interaction between agriculture and the rest of the economy.

The above requires a brief overview of agriculture's contribution, since this will help to clarify these interactions. Van Zyl et al (1988) elaborated on findings by Brand (1969) concerning agriculture's contribution to the rest of the economy:

- Agriculture is an important supplier of food to consumers at reasonable prices. Although different population groups' buying power and spending patterns differ, the importance of food to the domestic economy is emphasised by Döckel and Groenewald (1970), who estimated the income elasticity of food to be 0.60, which implies that a high percentage of any increase in income is spend on food.
- Agriculture's role as earner of foreign exchange should not be under-estimated. Although Van Zyl et al (1988) concluded that agricultural exports have not been a leading factor in South Africa's economic growth, it has played an essential, equilibrating role with respect to others sectors who contributed towards the drainage of foreign exchange.
- Faux (1990), through input-output analyses, showed that employment multipliers in agribusiness are greater than those that exist in the non-agricultural related sectors, and concluded that the business community and government development agencies should focus on agriculture-related processing sectors to create jobs. According to Van Zyl et al (1988) agriculture is an important source of labor for use in other sectors, and that employment in agriculture is also stable, even during times of recession.
- Agriculture has great importance as a supplier of raw materials to the secondary sectors, thus contributing to their development as well as to that of tertiary sectors.
- Lastly, agriculture is also a market for other industries, for example suppliers of fertilizers and pesticides, but may not play a large role in South Africa with respect to secondary and tertiary sectors. Its role in this respect should, however, not be under-estimated (Van Zyl et al, 1988).

Table 2.1 shows the gross value of agricultural production in South Africa for different years. The field crop and animal products sub-sectors are the major contributors to the gross value of agricultural production. Animal products were the most important sub-sector in 1993/94. From Table 2.1 it is also evident that horticultural products increased its contribution to the gross value of production substantially from 1960 to 1994.

The agricultural economy of South Africa is highly diversified. Fényes et al (1988) state that structural imbalances exist between agriculture and the rest of the economy, between commercial and developing sectors, and within commercial and developing sectors. An example of these imbalances is that the commercial agricultural sector uses roughly 86 percent of the total land area, whilst subsistence-orientated farms occupy only 14 percent of the area suitable for agriculture. Yet, both sectors support roughly the same number of people. There furthermore exist considerable differences in production levels between these two sectors, and indications are that the gap between these sectors has been widening over the years (Brand et al, 1992). Many commentators refer to this as South Africa's "two agricultures".

These two sectors do, however, share some common problems, such as the cost-price squeeze, inflation and drought. Some problems that are peculiar to the small farming sector include, among other things, insecure and fragmented land rights, non-viable and small farm units, inadequate water supply and infrastructure, financial support, etc. Another problem that is eroding the sustainability of this sector is the deterioration of natural resources. These problems have resulted in black rural areas becoming more dependent on food imports (Brand et al, 1992).

2.3 AGRICULTURAL POLICY IN SOUTH AFRICA

There has been a long history of state intervention in South African agriculture, which reached a zenith around 1980 with a host of laws, ordinances, statutes and regulations. These affected, and in many cases still affect, all aspects of agriculture, including prices of, access to and use of natural resources, finance, capital, labor, local markets, foreign markets and foreign exchange, etc. Importantly, these measures impacted unequally on different categories of farmers. The early part of the 20th century saw the initial steps aimed at the territorial segregation of white and black farmers.

Table 2.2: Growth in Employment and Capital Formation, 1950 to 1980

Period	Average Annual Growth (%)	
	Total number of farm employees	Real gross capital formation
1950 - 1960	2.08	3.21
1960 - 1970	4.38	5.34
1970 - 1980	-2.67	5.09

Source: Adapted from Van Zyl, et al (1987a; 1987b).

The second phase of structural change started around the time of World War II (Wickens, 1989) and lasted until the early 1980s. In the former homelands, there was increased pressure on food production despite increased investment in large-scale development projects under expatriate management. This period also saw the commercialization of white farming through the adoption of modern mechanical and biological technology, resulting in consistent growth in output within a policy environment heavily favoring increased production by large-scale owner operated farms.

Two trends were evident in the commercial sector during this period (Van Zyl et al, 1987a). Between 1950 and about 1970 there was a large expansion in cultivated farm area, probably because tractors replaced draught oxen in ploughing operations. Larger areas could be managed and more labor was required for harvesting. The increase in the labor required was ex-

acerbated by the increase in yields throughout the 1960s and 1970s as a result of improved biotechnology. The introduction of the combine harvester during the 1970s alleviated this problem but, together with credit, labor and tax policies favoring capital substitution and mechanisation, led to considerable shedding of labor from agriculture thereafter (Fényes and Van Rooyen, 1985). Table 2.2 shows these trends.

History has shown that neither racial discrimination nor price distortions in South African agriculture could be sustained, and the pressures on agriculture for reversal of these polices began to mount during the 1980s. This section details this period, which has been characterized by a reversal of the policies of the previous two decades, starting with increased liberalization of the agricultural sector and then proceeding to the urgent task of removing the racial barriers between black and white agriculture.

South Africa experienced a number of political changes and considerable political and economic instability during the 1980s. The constitution of 1983 gave birth to the tri-cameral parliamentary system and the concepts of 'own' and 'general' affairs. Violent uprisings, starting in 1984, led to a state of emergency and the intensification of economic sanctions in the mid-1980s.

2.3.1 Production, Consumption and Prices

As an important industry in the national economy, agriculture was also affected by numerous changes. The 1980s began with bumper harvests for maize and groundnuts in 1980/81, with an all-time record maize

Table 2.3: Production and Consumption of Agricultural Commodities, 1985-1995

Commodity	Imports	Exports	Production	Consumption		SI***
				Total*	Human**	
			(1,000 ton)			
Wheat	368	370	2,242	2,400	1,865	100.4
Maize (white & yellow)	515	2,106	8,019	7,012	2,839	114.4
Potatoes	4	11	1,161	1,142	942	101.7
Vegetables	5	27	1,776	1,755	1,580	101.2
Sugar	41	892	1,956	1,107	1,174	176.7
Beef	72	23	618	666	660	92.8
Mutton, goat's meat & lamb	17	0	176	193	191	91.2
Pork	2	2	117	117	116	100.0
Chicken	7	2	656	661	654	99.2
Eggs	0	3	199	196	186	101.5
Deciduous & sub-tropical fruit	0	511	1,484	974	876	152.3
Fresh milk	0	0	2,435	2,435	1,118	100.0
Dairy products	35	58	2,344	2,321	2,321	101.0
Sunflower seed oil	54	1	121	175	159	69.1
Citrus fruit (fresh & processed)	0	435	802	369	366	217.3

Notes:

* Available for use = Opening stock + Production - Closing stock + Imports - Exports

** Net human consumption = Available for use - Other uses - Losses, adjusted for extraction rate

*** SSI (self-sufficiency index) = Total production/Total consumption x 100

Source: Adapted from the Annual Food Balance Sheets of the Directorate of Agricultural Economic Trends, Department of Agriculture.

Table 2.4: Area Grown under Selected Field Crops, 1984-1993 (1000 ha)

Crop	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Maize	4,829	5,063	4,736	4,394	4,163	3,816	4,173	4,377	4,661	3,526
Wheat	1,983	1,946	1,749	2,009	1,843	1,563	1,436	750	1,075	1,048
Sorghum	388	401	326	228	196	166	191	239	227	180
Dry beans	81	87	77	80	87	100	70	57	69	59
Sugar cane	411	401	388	380	376	375	378	386	394	404
Tobacco	31	26	25	25	25	22	24	24	16	16
Potatoes	57	57	65	72	63	66	59	55	55	55

Source: Abstract of Agricultural Statistics (RSA, 1995).

harvest of 14.6 million tons. This was, however, followed by a period of drought between 1982 and 1984, resulting in widespread crop failures. Between 1984 and 1990, large surpluses of sorghum (1986), sunflower seed (1989), dry beans (1989), soybeans (1990) and sugar cane (1984) were produced. The field crop sector was again hit by drought in 1988 and 1991/92. Table 2.3 shows the production, consumption and the self-sufficiency index of the most important agricultural commodities produced in South Africa during the period 1985 to 1993. In spite of periodic droughts, South African agriculture still succeeded in producing surpluses of all the important staples.

Table 2.3 also indicates that in horticultural production, particularly fruit, South Africa is largely dependent on the export market. In contrast to crop and horticultural products, red meat has a self-sufficiency index of lower than 100. Shortages were supplemented by imports from, among other countries, Namibia, Botswana and some European countries. Red meat, coffee, rice, vegetables, animal fats and vegetable oils are the most important food products imported. The total gross value of agricultural production in South Africa was almost R15,000 million in 1987, whereas that of food imports amounted to about R1,200 million. Food exports in the corresponding period amounted to about R2,400 million (Van Zyl and Van Rooyen, 1991).

The cultivated area fluctuated throughout the decade (see Table 2.4). The decline since 1986/87 in the area under maize is particularly noticeable, and is part of a longer term trend. Maize plantings have decreased from an average of 4.6 million hectares per year in the periods 1970 to 1975 and 1980 to 1985 (after increasing from 3.2 million hectares in 1950 to 1955) to an average of 4.1 million hectares in 1990 to 1995. This is largely the result of the change in the price policy of the maize industry, which has resulted in a near 50

Table 2.5: Average Yields, 1950/55 to 1990/95 (ton per hectare)

	1950/55	1960/65	1970/75	1980/85	1990/95
Maize	0.88	1.22	1.82	1.78	1.94
Wheat	0.50	0.59	0.81	1.13	1.54
Sorghum	0.67	0.67	1.46	1.62	1.74

Source: Calculated from Abstract of Agricultural Statistics (NDA, 1995).

Table 2.6: Annual Increase In Producer Prices vs. Prices Of Inputs (1980 - 1991)

Product	Producer price	Prices of inputs
	(% increase p.a.)	
Summer grains	9.7	12.4
Winter grains	9.0	9.8
Dairy products	11.2	11.3
Poultry	11.9	11.9
Red meat	11.1	12.2
Vegetables	10.1	10.1
Fruit	13.5	13.3
Average	10.6	12.0

Source: Abstract of Agricultural Statistics (NDA, 1994).

percent drop in the real producer price of maize over the past decade (Vink, 1993). Other influences include the land conversion scheme introduced to take land out of maize production, as well as unfavorable climatic conditions.

Although the area under cultivation for maize, wheat and sorghum has declined during the period, production of these commodities grew steadily. Table 2.5 shows the trends in average yields for these commodities for the five periods from 1950 to 1995. These increases in average yields may have been the result of a combination of yield-increasing technology, a shift in production away from the marginally productive areas and more intensive agronomic practices.

Real producer prices in many of the major commodities such as maize, wheat, red meat and oilseeds have shown a marked decline since the beginning of the 1980s. Farmers also experienced a cost-price squeeze as a result of the prices of farm requisites rising faster than producer prices in nominal terms, as indicated in Table 2.6.

2.3.2 Agricultural Policy During the 1980s

Agricultural policy in South Africa during the 1980s was largely determined by the 1983 Constitution, and the continuation of a dualistic agricultural policy contained therein. Policy with regard to 'white' commercial agriculture was outlined in the White Paper on Agricultural Policy, tabled in 1984. The objective was to guide the development path of agriculture to ensure that factors of production would be used optimally with respect to economic, political and social development and stability, while also contributing to the promotion of an economically sound farming community. This was to be achieved through pursuing production, marketing and other goals.

Production goals included striving towards optimum use of natural agricultural resources; the preservation of agricultural land; the pursuit of a high number of well-trained and financially sound owner occupant farmers; and the optimum use of labor. The government's objective would be to ensure that the potentially productive land was maintained as agricultural land and would retain any other land identified as agricultural land for agricultural purposes.

Marketing goals included the pursuit of orderly marketing, duly considering the principles of the free market system and the maintenance of specific quality and hygiene standards of South African agricultural products. Since the government was advocating a free market system, the control boards needed to be applied with great circumspection to ensure that state involvement did not distort production, marketing and price structures.

General goals included self sufficiency in food; optimum participation in international trade of agricultural products; and maximization of agriculture's contribution to 'regional' development, incorporating the promotion of development in Southern Africa (i.e. the former homelands) and the rest of Africa.

Several acts were passed aimed at the affirmation of these goals, most notably the Soil Conservation Act, which came into effect on June 1, 1984. The aim of this legislation was to ensure the optimum use of agricultural resources. The act also introduced the Soil Conservation Scheme, the Flood Relief Scheme, the Bush Combat Scheme and the Weed Scheme.

In terms of the Agricultural Resources Act (Act 43 of 1983), some of the important regulations aimed at

the conservation of natural resources, by maintaining the productive capacity of the soil, were:

- No cultivator may plough or cultivate virgin soil without written permission. Permission should be sought from the local extension office at least three months before the planned cultivation.
- Any soil user should not allow excessive soil losses through water erosion on cultivated soil; this should be prevented by suitable conservation works, a crop rotation system, strip cultivation or by leaving sufficient crop residues. Any soil user that allows excessive wind erosion could be forced to protect it, i.e. erect wind breaks.
- Irrigated soils should be protected from water logging and becoming salinated through the necessary drainage works.
- Wetlands areas may not be cultivated or drained without written permission.
- Drainage water from a water course may not be re-routed to another course. A soil user should not erect any obstruction that will disrupt the natural pattern of the water course.
- No one should damage his/her natural grazing area by over-stocking or mismanagement. A soil user exceeding his/her official grazing capacity will forfeit all claims for financial aid in the form of subsidies for soil conservation works and drought aid.

(1) Food Self-sufficiency

One of the main aims of agricultural policy was 'self-sufficiency in respect of food, fiber and beverages and the supply of raw materials to local industries at reasonable prices' (RSA, 1984). The White Paper (RSA, 1984: 8-9) motivates this policy aim as follows:

> 'For any country, the provision of sufficient food for its people is a vital priority and for this reason it is regarded as one of the primary objectives of agricultural policy. Adequate provision in this basic need of man not only promotes, but is also an essential prerequisite for an acceptable economic, political and social order and for stability.'

In order to achieve this aim, the South African agricultural bureaucracy was geared to support the white commercial farmer, especially in field crops and livestock. Farmers were protected from foreign competition, received various forms of direct subsidies, often received producer prices at a premium relative to world prices and had access to the latest and most productive mechanical and biological technology. Through these measures, South Africa maintained its position as a surplus agricultural producer and achieved the aim of self-sufficiency in most commodities. However, these measures were often in conflict with environmental aims as contained in the Agricultural Resources Act. The cultivation of maize, for example, became so profitable that large stretches of marginal land came under production (Brand, et al, 1992).

The policy of food self-sufficiency should be seen in the context of both global trends and the government's political agenda. Many countries

Table 2.7: Government Subsidies to the Wheat and Maize Industries (1980 –94)

Year	Maize (R mil)	Wheat (R mil)
1980	44.7	116.4
1981	59.5	162.1
1982	82.9	181.9
1983	69.9	193.4
1984	132.4	276.6
1985	215.0	194.3
1986	250.0	180.5
1987	151.0	147.4
1988	359.0	132.0
1989	79.9	105.9
1990	76.0	60.0
1991	100.0	---
1992	100.0	---
1993	---	---
1994	---	---

Source: Abstract of Agricultural Statistics (NDA, 1994).

Table 2.8: Summary of Reforms Under the Marketing Act and Other Legislation

Scheme/Product	Year of establishment	Recommendation by CIMA (1993)	Recent reforms (including those before 1994)
Single Channel Fixed Price Schemes			
Maize	1938	Change necessary.	Shift to pool-type pricing (1987); prohibition on erection of grain silos repealed; grain sorghum established as surplus removal scheme (1986); scrapping of control measures on buckwheat under consideration; scrapping of price control on maize meal; change to buyer of last resort (April, 1995); one channel marketing system abolished.
Winter cereals	1938	Change necessary.	Abolition of restrictive registration of millers and confectioners; elimination of bread subsidy (1990); price control on flour, meal and bread, and fixing of millers' margins scrapped (1991); simplification of grading system for wheat (1991).
Single Channel Pool Schemes			
Oilseed	1952	Change necessary.	Abolition of import control measures on oilcake & fishmeal; groundnuts under surplus removal scheme.
Leaf tobacco	1939	Statutory power unnecessary.	Discontinuation of single channel marketing system under the Co-operatives Act. Export subsidies suspended.
Deciduous fruit	1939	Moratorium on statutory powers.	No change.
Citrus fruit	1939	Voluntary organization.	Domestic market control abolished (1990)
Bananas	1957	Abolished in 1993.	
Lucerne seed	1952	Statutory powers unnecessary.	Switch to surplus removal scheme rejected (1990); Board permitted private imports and exports (1992).
Wool	1972	Statutory powers unnecessary.	Single channel pool scheme discontinued. Wool Board voluntary organisation providing market information etc.

Table 2.8: Summary of Reforms Under the Marketing Act and Other Legislation, Con't.

Scheme/Product	Year of establishment	Recommendation by CIMA (1993)	Recent reforms (including those before 1994)
Dried fruit	1938	Statutory powers unnecessary.	No change.
Chicory	1939	No intervention.	Abolished in 1993.
Rooibos tea	1954	Statutory powers unnecessary.	Abolished in 1993.
Mohair	1965	Voluntary organization.	Abolished on January 31, 1994.
Dairy	1956		Consumer price control on fresh milk abolished (1983); price control on butter and cheese abolished (1985); price stabilisation activities ended (1992); Dairy Board abolished (Dec. 31, 1993). Milk Board (Fresh Milk - voluntary organization) established Jan. 1, 1994.
Surplus Removal Schemes (or Price Support Schemes)			
Red meat	1945	Change necessary.	Abolition of restrictions on movement from uncontrolled to controlled areas (1992); abolition of restrictive registration of producers, abattoir agents, butchers, dealers, processors and importers.
Eggs	1953	Statutory powers unnecessary.	Abolition of production and pricingcontrol in 1993. Abolition of Egg Board in 1994.
Potatoes	1951	Statutory powers unnecessary.	Abolished in 1993.
Dry beans	1955	Statutory powers unnecessary.	Abolished in 1993.
Sorghum	1957	Statutory powers unnecessary.	No change.
Supervisory and Price Regulation Schemes			
Canning fruit	1963	Statutory powers unnecessary.	No change.
Cotton	1974		No change.

Table 2.8: Summary of Reforms Under the Marketing Act and Other Legislation Con't.

Scheme/Product	Year of establishment	Recommendation by CIMA (1993)	Recent reforms (including those before 1994)
Control in terms of promotion			
Karakul pelts	1968		Karakul scheme and board abolished circa 1985.
Control in terms of other legislation			
Sugar cane	1936 #		Reform of cane quota system (1990).
Wine	1918		Abolition of production quota system (1992).
Ostriches and ostrich products	1958 * 1988 **	Statutory single channel control to be repealed.	Abolition of single channel marketing system (1993).
Lucerne hay	1958		Abolition of single channel marketing system (1993).The last government notice allowing a co-operative to implement single channel marketing was withdrawn in 1993 (Oranje Co-operative).

Notes:

\# The Sugar Act of 1936 established control measures in the sugar industry. The act makes provision for a Sugar Agreement, established in 1943, to oversee the industry.

* Only ostrich products.

** Ostriches and ostrich products.

protected agriculture, especially in the post-World War II period. Surplus production was seen as a way to earn foreign exchange and to allay fears of chronic food shortages. In South Africa, further impetus was given to this blend of mercantilism and Malthusian fears of the political imperative to remain independent from an increasingly antagonistic and hostile world. With the threat of sanctions becoming a reality in the 1970s and 1980s, the policy of food self-sufficiency was an integral part of the country's overall attempt at achieving self-sufficiency.

The fact that per capita food production levels were maintained (and will in all probability still keep on increasing over the next two decades), however, says little about the nutritional status of the population. The Committee for the Development of a Food and Nutrition Strategy for Southern Africa (1990), appointed by the Minister of Agriculture, attempted to identify the numbers of nutritionally deficient people in the country. It estimated that, in 1989, there were around 16.3 million people in South Africa with an income lower than the minimum subsistence level (MSL). These numbers were substantiated in the Living Standards Survey conducted by the South African Labor and Development Research Unit at the University of Cape Town as part of the Project for Statistics on Living Standards and Development.

However, a more accurate description of the situation can be gleaned from anthropometric data. Estimates according to these somewhat conservative norms show that there are at least 2.3 million people in South Africa

who can be considered for nutritional assistance, as against the 16.3 million according to income criteria (in 1990).

(2) Agricultural Subsidies

One of the major instruments to achieve the goals of the White Paper of 1984, apart from the Agricultural Marketing Act, was agricultural credit. Agricultural policy in this period was characterized by the large sums of government subsidies to farmers, usually in the form of drought aid and other disaster payments. These are detailed later in this chapter. The government also paid industry subsidies to, among others, the wheat, maize and dairy industries. The subsidy to the wheat industry was paid to keep consumer prices of wheat and wheat products (flour, bread) as low as possible. The payment to the maize industry was in terms of the government's subsidization of the Maize Board's handling and storage costs, in order to keep selling prices of maize as low as possible. The extent of subsidies to the wheat and maize industry is shown in Table 2.7.

(3) Changes in Agricultural Policy

Within this policy framework, and at times seemingly despite stated policy, the sector faced increasing deregulation and market liberalization from the mid-1980s. Vink (1993) argues that the deregulation of the agricultural sector started outside agriculture in the late 1970s when the financial sector was extensively liberalized following the publication of the De Kock Commission Report.

The immediate effect on agriculture came from changes in the external value of the currency and in the interest cost of farm borrowing. Changes to the reserve requirements of the banking sector made it impossible for the Land Bank to continue subsidizing farmers' interest rates. The use of interest rate policy by the Reserve Bank led to a rise in interest rates to very high levels, which resulted in interest becoming the single largest cost of production in agriculture at that time. These changes led to the increasing exposure of farmers to market-related interest and exchange rates. The decline in the value of the Rand resulted in farm input prices, which have a relatively large import component, rising faster than farm output prices.

Other changes in the broader political economy which led to changes in agricultural policy were: the lifting of controls over the movement of labor in South Africa in the mid-1980s; the considerable micro-economic deregulation leading to increased activity in the informal sector, especially in food supply services (Vink, 1993); and the momentous political changes that were set in motion on February 2, 1990.

Within this climate of macroeconomic and political change, a number of shifts in agricultural policy took place during the 1980s (Brand et al, 1992; Vink, 1993):

- Budgetary allocations supporting white farmers declined by some 50 percent between 1987 and 1993 (see also Vink and Kassier, 1991 and LAPC, 1993).
- The real producer prices of important commodities such as maize and wheat declined by more than 25 percent in real terms since 1984 and 1986, respectively.
- The tax treatment of agriculture changed, for example, by the extension in the period within which capital purchases could be written off from one to three years, thereby reducing the implicit subsidy, and the effective 'ring fencing' of agricultural incomes.
- There was a shift away from settlement schemes and large-scale projects as the major instruments of agricultural development in the developing areas (the former homelands), in favor of an approach based on the provision of farmer support services such as infrastructure, extension services and research, and access to credit and markets.
- The scrapping of the Land Acts and related legislation that enforced the racially based segregation of access to land. This was the most visible of the policy changes in agriculture following the important political events of February 1990.
- Certain elements of labor legislation were made applicable to farm labor and the farm sector has now become part of the mainstream of industrial

Table 2.9: Abolition of Price Control in the Food Industry

Product	Level	Year abolished	1981 Subsidy (R million)
Bread	Retail and Wholesale	1991	162.1
Maize Marketing Margin		1991	59.4
Dairy			3.7
Cheese	Retail	1985	
	Wholesale	1986	
Milk	Retail	1983	
	Wholesale	1983	
	Producer	1987	
Butter	Retail	1985	
	Wholesale	1988	
Fertilizer		1987/88	11.0
Stock Feed and Grazing			15.7
Transport rebates			4.0
Total			255.9

Source: Abstract of Agricultural Statistics (NDA, 1982).

relations in South Africa. The Basic Conditions of Employment Act was made applicable to farm workers in May 1993.

- There was a reduction in the institutional confusion by the amalgamation of all the 'own' affairs and 'general' affairs departments of agriculture and through the dismantling of the Department of Development Aid.
- The removal of quantitative protection and the introduction of tariffs for farm commodities, mainly as a result of the pressures arising from the Uruguay Round of the GATT and the signing of the new GATT deal in April 1994.

In addition, there were a number of direct changes affected through implementation of the Marketing Act.

(4) Reform of the Agricultural Marketing System

Agricultural marketing policy was largely determined by the Marketing Act (Act 59 of 1968, as amended). The act consisted, among other issues, of a list of potential policy instruments that could be used to control the marketing of a commodity. It also enabled the Minister of Agriculture to proclaim a marketing scheme, and appoint a Control Board to control the marketing of a particular commodity in a prescribed manner. A total of 23 Control Boards were established under the Marketing Act.

Since the early 1980s there has been a general reduction in the use of price controls and registration as instruments of marketing policy (e.g. in the maize and wheat industries). There were also shifts to more market-based pricing systems, away from the cost-plus pricing procedure that had traditionally been used. In addition to the macro factors described above, there was also considerable pressure from within the system, with many farmers becoming increasingly unhappy with aspects of the controlled marketing of many agricultural products. There was also a realization of the poor performance of the agricultural sector in aggregate, as measured by the very slow rate of productivity growth (Thirtle et al, 1993).

The trend of market liberalization was further enhanced by the pressures emerging from the GATT negotiations for the abolition of quantitative import controls and the introduction of tariffs on all agricultural commodities. The replacement of quantitative controls

on external trade by tariffs is intended to reduce the distortions created by quantitative administrative controls, to create a more commercial environment in the planning of imports, to reduce the role of government in the allocation of licenses, to limit the use of quantitative controls, and to increase the extent of competition. A general policy of tariffication has been in operation since 1985, but this has only begun to be applied to agricultural commodities since 1992. By 1994, tariffs were established for poultry, tobacco, vegetable oil, oilcake and red meat, and an overall strategy was developed for submission to GATT. The Report of the Committee of Inquiry into the Marketing Act (Kassier, 1992), appointed by the Minister of Agriculture in June 1992, was instrumental in supporting this process of deregulation. Since the release of the Kassier Report in January 1993, a total of eight marketing schemes and boards were abolished, while the one channel pool scheme of the Wool Board was abolished., The Wool Board, however, remained intact to perform product development, advertising and other services. The impact of these events on the reform and deregulation of South Africa's agricultural marketing system is evident from Table 2.8.

(5) Liberalization of Price Controls in the Food Sector

One of the important aspects of marketing deregulation was the liberalization of price control on a wide range of products. Examples are presented in Table 2.9. In their 1992 discussion document, the Board on Tariffs and Trade argued that the abolition of price controls was directly responsible for sharp price increases in consumer prices.

(6) Change in Tax Policy

The farm sector has traditionally received differential tax treatment from the receiver. Lamont (1990) estimated that income tax concessions to farmers amounted to 70 percent of their theoretical tax bill in 1981/1984. This seems to have changed in recent years. By the late 1980s the agricultural sector contributed a fair share to national revenue. Although this contribution is lower than its contribution to GDP, which declined from about 7 percent in 1980 to under 5 percent in the 1990s, farmers provide social services that are not usually expected of other business enterprises. What is important is that although agriculture's share of revenue remained fairly constant over the years under consideration, it increased from 1986. This coincides with the removal of major tax concessions in the treatment of certain capital purchases. Resources were not optimally deployed because capital formation occurred at the expense of a relatively cheap labor resource. Such tax concessions tend to result in overinvestment in good years but lead to cash-flow problems in bad years (LAPC, 1993).

During the second half of the 1980s, tax concessions were reduced. Assets had to be depreciated over three years at rates of 50 percent, 30 percent and 20 percent per annum, respectively. Although this amounted to a significant reduction in tax concessions, depreciation provisions for agriculture are still more generous than for other sectors.

(7) Budgetary Allocations to Agriculture

During the 1980s, expenditure on agriculture, forestry and fishing increased in nominal terms from R833 million in 1982/1983 to R2 240 million by 1990/1991. However, real expenditure rose between 1982/1983 and 1984/1985, but fell back for the rest of the decade (LAPC, 1993). Figures on budget expenditure provided by the Central Statistical Service indicate that white farmers' share of the agriculture budget was declining in the latter part of the 1980s. Between 1988/1989 and 1990/1991, white agriculture's share of the budget dropped from 72 percent to 61 percent. Conversely, over the same period, the former homelands received a greater proportion. Auditors' reports and expenditure estimates of the government indicate a similar trend. These figures show a steady fall in white agriculture's share of total expenditure from 79 percent of the budget in 1985/1986 to 52 percent in 1990/1991.

(8) Agricultural and Rural Development Policy

Different policies applied to white commercial agriculture and to black small-scale farmers in the former 'homelands'. Three clearly defined approaches to agricultural development in the former homelands can be identified, i.e. betterment planning to the late 1970s; centrally managed project farming and farmer settle-

ment projects during the 1970s and 1980s, and the more broad-based farmer support programmes supported by the Development Bank of Southern Africa since the late 1980s (cf. Ellis-Jones, 1987; Christodoulou and Vink, 1990; Van Rooyen et al, 1987; Van Rooyen, 1993; Bromberger and Antonie, 1993).

The 1970s were the time of the large-scale, centrally managed estate project farms (Christodoulou and Vink, 1990). This was particularly the case with industrial crops 'where large units were desirable' (Van Wyk, 1970 : 66). The project farming approach obtained a further boost with the establishment in 1973 of an agricultural division in the Bantu Investment Corporation. According to Bromberger and Antonie (1993), Christodoulou and Vink (1990) and Christodoulou et al (1993), it appears that substantial financial losses were the norm with these schemes. Further, the distribution of benefits was limited in relation to total need and to aggregate resources available for development. Although higher levels of resource use, production and wage employment were achieved through these 'modern' farming enterprises managed by parastatal companies and consultants, little was done to promote a class of self-employed farmers or to improve farming conditions for smallholders outside these schemes. Schemes were later adjusted to settle selected persons as 'project farmers' operating under paternalistic control (Van Rooyen, 1993). Occupiers of plots were

Table 2.10: Total Domestic Support to South African Agriculture (PSE) (R1,000)

	Description	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94
(a)	Value of production: Products with MPS*	11,321,897	13,454,158	13,784,297	15,736,341	12,872,328	6,467,791
(b)	Value of production: Products without MPS	5,231,386	5,965,538	6,910,111	7,497,910	11,193,516	11,860,609
(c)	Direct payments	113,549	115,621	119,871	91,674	89,075	79,803
(d)	Adjusted Value of Production (a+b+c)	16,668,832	19,535,317	20,814,279	23,325,925	24,154,919	28,408,203
Policy transfers to agriculture:							
(e)	Market price support	216,819	701,428	1,308,831	2,321,722	2,448,684	2,119,873
(f)	Direct income support	367,977	335,768	332,025	250,019	2,616,106	386,477
(g)	Indirect income support	942,692	774,528	703,863	819,426	1,278,611	1,048,097
(h)	General services	422,001	446,259	503,761	512,940	1,155,325	564,305
(i)	Total PSE (e+f+g+h)	1,949,489	2,257,983	2,848,480	3,904,107	7,498,726	4,118,752
	Percentage PSE (i/d)	11.70	11.56	13,69	16.74	31.04	14.50

Note: MPS = Market price support

strictly selected, and they had to farm according to direction and under supervision (Van Wyk, 1970: 66). Participation by so-called farmers was accommodated by using farmer committees to assist the project manager. These farmers, however, were little more than paid wage laborers with virtually no control over their production activities.

With time, disillusionment set in. The projects were capital-intensive, expensive to operate, often incurred losses and rarely involved spill-overs or linkages with the surrounding communities. They were viewed as 'islands of prosperity amidst an ocean of poverty' (Bromberger and Antonie, 1993). In acknowledging the limitations of such projects, an alternative approach to agricultural development was designed. The Farmer Support Programme (FSP) was introduced in 1986 (Van Rooyen et al, 1987; Singini and van Rooyen, 1995), trying to achieve a shift away from investment in projects to a programme which could provide access to support services for a large number of smallholders and rural households in a broad-based manner. An important motivation for this programme was the promotion of equitable access to support services, resources and opportunities.

2.3.3 Some Effects of the Changing Farm Policy

(1) General

Agricultural policy in South Africa has changed significantly over the past decade. These changes in farm policy have had significant effects on the agricultural sector as a whole, and on the different farming regions. Aggregate data shows that the sector is becoming more flexible in some parts of the country. This is highlighted by an improved aggregate debt service ratio along with financial difficulties for some groups of farmers; the increasing land-use intensity in high potential regions and 'over-cropping' in more marginal regions; the aggregate decline in farm size; shifts in the cropping pattern; and the relative absence of yield effects.

The effects of these changes in farm policy can be traced through variables such as the financial position of farmers, changing land use patterns and farm size and ecological considerations.

Much has been made of the increase in total farm debt in the period since 1980. At the aggregate level, however, the ability of farmers to service their debt has improved since the mid-1980s, although it is evident that the size of debt and the ability to service debt differs between regions and among farmers. Examples include the successful use of credit to gear production by farmers in high-potential regions, especially where crops are produced for export; the more extensive production systems being followed by maize farmers in the Highveld, that is, by using fewer production inputs; and the higher rates of sequestration of farming enterprises in the lower-potential regions. Many of these changes are reflected in changing land use patterns.

The changing land use patterns in commercial farming have manifested themselves differently in the different regions of the country. They are related to the policy changes discussed earlier through changes in relative product prices and factor costs, the cash flow position of farmers, shifts in tax incidence and so forth. A theoretical analysis of the effects of the changes in farm policy over the past decade leads to the conclusion that a decline in average farm size was

Table 2.11: Average Annual Growth Rates in Real Net Farm Income, 1973 to 1994 (%)

Period	NFI	TFP	Terms of trade
1973-91	-1.06	1.48	-2.63
1973-83	-8.14	0.27	-3.27
1983-94	6.24	4.63	-3.11

Notes: NFI: Net Farm Income
TFP: Total Factor Productivity
Terms of trade: Output prices / input prices

Table 2.12: Annual Growth Rates of Debt from Selected Sources

Category	1980-1990	1985-1990
Land Bank	2.98%	12.7%
Agricultural co-operatives	1.0%	10.29%
Department of Agriculture	5.49%	10.49%
Private Persons	-6.48%	-6.66%

indeed possible. However, this would be the aggregate effect of a number of more specific micro-level and regional changes. Policy effects which could lead to downward pressure on farm size include (Brand et al, 1992):

- A higher incidence of part-time farming and of land rentals resulting from the need to find other sources of capital and to use less capital;
- More intensive farming in high-potential areas as farmers exploit growing local and foreign markets;
- Attempts to manage risk through mixed farming systems, that is, by more intensive management in the high-potential areas;
- The development of urban agriculture which, by definition, is suited to small-scale farming;
- Distress-selling of parcels of land in areas which have become vulnerable to the deregulation of controlled markets;
- The introduction of elements of farming labor legislation which could result in innovations in the means of access to land, including farmer settlement, share-cropping and sectional title arrangements;

On the other hand, there are a number of factors which could put an upward pressure on average farm size, including:

- The declining use of production inputs such as fertilizer and agrochemicals, leading to more extensive farming;
- The switching from crop production to livestock ranching in the more marginal cropping areas, including planted pasture;
- The switching to lower yielding but more drought resistant crop cultivars; and
- The expansion of the corporate farming sector.

Agriculture is a prime user of natural resources. Although it supplies food and fiber, foreign exchange and employment opportunities to the South African economy, a high price has been paid in terms of the degradation of natural ecosystems. The imbalances created by biotic simplification (monoculture), lack of managerial expertise and agricultural policies, are evident in many parts of the country. Recent studies by the Department of Agriculture show that at least 9 million hectares of arable land and 21 million hectares of grazing land in the 'white' farming areas are at present subject to some or other form of wind or water erosion. Of this, some 11 million hectares or 13 percent of the total agricultural land in these farming areas, have been damaged by mild or severe erosion. The erosion of topsoil is unacceptably high and much of the irrigation land has become degraded through salination, while natural grazing land is seriously overstocked.

(2) Changes in Domestic Support to South African Agriculture

Helm and Van Zyl (1994) calculated the total support received by South African agriculture during the period 1988/1989 to 1993/1994, using the Producer Subsidy Equivalent (PSE) measure. The results are shown in Table 2.10.

The total PSE was at its lowest during 1988/89, with market price support accounting for only 11 percent of total assistance, the remainder being financed by taxpayers. Producer prices of sugar, rye, chicory, eggs, beef, sheep and dairy products were higher than the representative world prices. In 1989/1990 market price support accounted for about 31 percent of total

assistance. The reduction in indirect income support was mainly due to the substantial reduction, and eventual termination, of the production input subsidy. In 1990/1991, the total PSE again increased as a result of substantially higher domestic producer prices for certain products, together with a decline in world prices. Market price support accounted for about 46 percent of total assistance (Table 2.10).

Changes in producer prices relative to world prices of agricultural products were once again the main reason for the higher market price support, together with the subsequent increase in the total PSE, in 1991/1992. Market price support accounted for about 60 percent of total assistance and was 37 percent higher than the previous year. The large change in the percentage PSE in 1992/1993 was the result of a huge once-off increase in direct income support to farmers from R250 million the previous year to R2.6 billion (Rimmer, 1993). This came in the form of a drought relief package, announced by the government in 1992, which consisted of R2.4 billion in debt relief.

(3) Effects on Productivity in South African Agriculture

The changes in agricultural policy also had some effect on total factor productivity (the ratio of aggregate output to an aggregate of all inputs combined) in South African agriculture. The results of TFP calculations by Thirtle et al (1993) show that between 1947 and 1991 the output index grew by nearly 350 percent, or an

Table 2.13: Area Planted, Production and Consumption of Maize

Season	Area Under Maize (thousand ha)	Total Production (million tons)	Consumption (million tons)
1984/85	4,028	4,405	5,725
1985/86	3,913	7,909	5,479
1986/87	4,054	7,926	5,206
1987/88	4,029	7,068	5,371
1988/89	3,657	6,731	5,563
1989/90	3,778	11,552	6,242
1990/91	3,457	8,342	6,601
1991/92	3,026	7,826	6,871
1992/93	3,452	2,955	6,647
1993/94	3,623	9,077	6,471

Table 2.14: Average Yield of Maize (White and Yellow) Over the Past 10 Years

Year	White Maize Yield (t/ha)	Price (R/t)	Yellow Maize Yield (t/ha)	Price (R/t)
1986/87	1.72	308.99	2.08	285.27
1987/88	1.54	310.00	1.93	288.00
1988/89	1.68	322.00	2.00	295.00
1989/90	2.95	354.00	3.15	333.00
1990/91	2.22	395.00	2.59	360.00
1991/92	2.23	464.00	2.49	419.00
1992/93	0.67	530.00	1.06	495.00
1993/94	2.23	545.00	2.78	505.000
1994/95	2.83	515.00	3.35	495.00
1995/96	2.76	580.00	3.05	535.00

Source: Maize Board (1996)

Table 2.15: Area Planted, Production and Consumption of Wheat in South Africa

Marketing Season	Area (in thousand ha)	Production (in thousand tons)	Consumption (in thousand tons)
1984/85	1,919	2,332	2,083
1985/86	1,951	1,679	2,122
1986/87	1,926	2,321	2,176
1987/88	1,729	3,135	2,427
1988/89	1,985	3,535	2,385
1989/90	1,830	2,026	2,338
1990/91	1,550	1,700	2,248
1991/92	1,436	2,143	2,228
1992/93	742	1,238	2,216

average rate of 3 percent per annum. During this period, the index of input use more than doubled, growing at 1.8 percent per annum. However, input use grew at over 2.5 percent per annum until 1979, but has fallen by 0.9 percent per annum since then. This fall explains the recent growth in the TFP index. Over the full period, TFP grew at 1.3 percent per annum, but accelerated to 2.88 percent per annum from 1981.

These TFP results are useful in explaining the effects of agricultural policy. The growth rate in TFP is greater than would be expected on the basis of Liebenberg and Groenewald's (1990) preliminary study of productivity in grain production. The increasing rate of growth over the period is in accordance with Van Zyl and Groenewald's (1988) perception that farmers' profits came under increasing pressure as inflation gathered pace. The rapid growth of productivity since 1983 is in agreement with the regional econometric study by Van Schalkwyk and Groenewald (1992), which found evidence of substantial growth in output in some regions since 1981. The growth in productivity can be explained by the increasing competitive pressures within the industry as a result of the policy reversals and removal of price distortions caused by credit, tax and macro policies.

In a further study on TFP growth and growth in net farm income, Van Zyl et al (1993) calculated that total factor productivity grew at 4.63 percent annually since 1983, sufficient to counter a decline of 3.11 percent in the terms of trade during the same period. The result was a growth of 6.24 percent in real net farm income (NFI) (Table 2.11).

Table 2.16: The Competitive Position of the South African Oilseed Industry

Item	Unit	1995	1996
Soybeans:			
Import Price (harbor)	R/ton	1,553	1,598
SA Producer Price	R/ton	920	1,200
Sunflowers:			
Import Price (harbor)	R/ton	1,449	1,452
SA Producer Price	R/ton	980	850-950
Groundnuts:			
Import Price (Guateng)	R/ton	4,300	4,544
SA Producer Price	R/ton	2,400	3,000

Source: Agrimark Trends (1996)

Table 2.17: Average Yield and Price of Sunflower Seed, 1986/87-1995/96

Year	Yield (t/ha)	Price (R/t)
1986/87	0.84	503
1987/88	0.98	566
1988/89	0.91	580
1989/90	1.05	672
1990/91	1.21	722
1991/92	1.01	780
1992/93	0.38	843
1993/94	0.82	936
1994/95	0.92	1,004
1995/96	1.12	1,050

Source: Oilseed Board, 1996

(4) The Financial Position of Farmers

Declining farm profitability as a result of the reversal of distortionary policies (and adverse weather conditions) caused severe cash-flow problems in agriculture (Van Zyl and Van Rooyen, 1991). Liquidity problems have affected the financial standing of commercial agriculture in three ways: (a) debt loads increased; (b) loan arrears mounted; and, (c) sequestrations increased. The total debt of farmers has increased substantially since the mid-1970s.

The decline in farm profitability also seems to have caused a substitution of short-term for long-term debt from 1970 until the mid-1980s. The ratio of short-term to total debt increased from 28.2 percent in 1970 to 54.6 percent in 1985, and peaked in 1991 at 57 percent (World Bank, 1994). The share of total farm debt at commercial banks and co-operatives increased from 20 percent and 8 million percent respectively in 1970 to 30 percent and 25 percent respectively in 1991, again indicating the switch to short-term debt.

The high growth rates of farm debt per annum for the period 1980 to 1985 (see Table 2.12), is attributable mainly to drought and general economic conditions, especially the increase in interest costs. Interest rates, drought, volume of field crop production, real GNP and the ratio of input to output prices have been shown

Table 2.18: Production, Area and Yield of Sorghum, 19945/95

Province	Production (tons)	Area (ha)	Yield (t/ha)
Western Cape	0	0	0.00
Northern Cape	0	0	0.00
Free State	223,600	87,620	2.67
Eastern Cape	1,000	200	5.00
Natal	0	0	0.00
Mpumalanga	164,700	56,735	2.90
Northern Province	27,500	11,000	2.50
Gauteng	10,000	3,220	3.11
North-West	43,200	15,345	2.82
Total	480000	174120	2.76

Source: Sorghum Board (1996)

Table 2.19: Production, Area and Yield of Cotton, 1994/95

Province	Production (tons)	Area (ha)	Yield (t/ha)
Western Cape	0	0.001	0.00
Northern Cape	21,039	8,771	2.40
Free State	0	0.01	0.00
Eastern Cape	0	0.01	0.00
Natal	3,440	6,700	0.51
Mpumalanga	794	1,522	0.52
Northern Province	30851	37,141	0.83
Gauteng	0	0.01	0.00
North-West	0	0.01	0.00
Total	56,123	54,134	1.04

Source: NDA, 1996

to have had a relatively large impact on the real debt burden in the period from 1970 to 1985 (Van Zyl et al, 1987b).

In the mid-1980s, the South African Agricultural Union carried out a national survey on the financial situation of all farmers. The survey revealed that 49 percent of farmers were financially sound at the end of 1983, but the percentage in this category was expected to fall below 39 percent at the end of 1984. While the financial position of farmers older than 50 was generally sound, 38 percent of farmers between the ages of 25 to 35 were in a critical financial position. This proportion increased to well over 50 percent by the end of 1984.

Many of these farmers have left the industry, but the majority have been kept on their farms through government intervention in the form of 'cheap' credit and debt relief to insolvent or near-insolvent farmers. In 1993, around 17,000 farmers still benefited from such assistance, provided through the Financial Assistance Schemes of the Department of Agriculture. If it is argued that these farmers are also the most inefficient, it can be said that the policy of blanket debt relief and subsidies only adds to the financial unsustainability of the sector and the entrenchment of inefficiencies. During the 1980s, the state granted financial assistance in one form or another to some 27,000 farmers. Direct financial assistance to these farmers over the decade amounted to R1,728.1 million, while subsidies totalled R2,353.6 million.

Table 2.20: The Availability of Beef on the SA Market (1990-1994) (tons)

Year	Slaughtering*	Imports		Exports	Meat Board		Total
		Neighbors	Overseas	Overseas	Purchases	Sales	Availability
1990	441,905	23,723	8,171	860	597	681	473,023
1991	462,604	21,152	3,133	1,010	578	1,400	486,701
1992	478,915	16,610	3,900	1,439	14,466	3,038	486,831
1993	466,698	16,434	7,603	2,915	11,552	9,966	486,233
1994	400,887	19,888	41,775	2,173	5	6,214	466,586

Note: * Includes livestock imported from Namibia and slaughtered locally

Source: Adapted from the Meat Board (1995)

Table 2.21: Per Capita Consumption of Red Meat and Poultry (1986-1994) (kg)

Year	Beef	Mutton	Pork	Poultry
1986	17.49	4.18	3.17	16.60
1987	15.99	4.31	3.16	17.06
1988	15.18	4.08	3.27	17.98
1989	15.61	4.19	3.46	18.66
1990	16.12	4.92	3.67	19.46
1991	16.45	5.06	3.48	20.16
1992	16.68	4.46	3.56	19.90
1993	15.94	4.16	3.36	18.36
1994	14.97	3.79	3.39	17.47

Source: Meat Board (1995)

The declining profitability in many parts of the agricultural sector would have produced substantial declines in farm incomes had it not been for state aid. However, in spite of this generous financial assistance, loan arrears increased as the farm financial crisis worsened. It also did not succeed in countering the structural decline of farm profitability since the early 1980s, and the debt burden worsened. The increased importance of short-term debt was a major sign of the worsening debt crisis in farming. An important component of the short-term credit (mainly at cooperatives) fell under a carry-over scheme for farm debt which was guaranteed by the government. This programme, initially introduced after the 1982/1983 drought became a permanent feature, escalated as a result of the 1991/1992 drought when the guarantee required by the government rose from an initial R800 million in 1983 to R2.4 billion in 1992.

The drought relief package announced by the government in 1992 consisted of a R2.4 billion debt relief (the guarantee referred to above) plus an additional R1 billion drought relief amounting to a total of R3.4 billion. This constituted a substantial recapitalization of the least efficient sub-sectors of the agricultural sector, namely the livestock and grain producers in the summer and winter rainfall areas. It is clear from this discussion that the approach of blanket debt relief has been very costly, and has entrenched inefficiency and inequality in the commercial farming sector.

2.4 OVERVIEW OF THE PRODUCTS INVESTIGATED IN THIS STUDY

2.4.1 Maize

Maize is of major importance for South Africa and has yielded over 15 percent of the gross value of all agricultural products, while accounting for about 40 percent of the cultivated area in the country (World Bank,

Table 2.22: Overseas Imports of Red Meat (tons)

Year	Beef	Mutton	Pork
1991	3,132	513	927
1992	3,899	5,608	1,668
1993	7,602	4,982	1,713
1994	41,775	36,721	13,494

Source: Meat Board, 1995

1994). It is the largest harvested crop for local consumption, and an important source of carbohydrates for humans and animals alike. It is known that the country has regularly produced maize surpluses, with the exception of 1982/1983 and 1983/1984 drought years.

Table 2.13 shows the production and consumption of maize in South Africa. From the table it is evident that the area under maize production has shown a downward trend since 1986/1987. This can be attributed to changes in agricultural policies. Table 2.14 depicts the yield of maize (white and yellow).

2.4.2 Wheat

South Africa regularly imports wheat (Table 2.15). The reduction in area planted in recent years is due mainly due to drought conditions experienced by the country's central wheat regions and changes in government agricultural policies. Wheat consumption also showed a decline from 1988/1989.

2.4.3 Oilseeds

Oilseeds are important in providing protein raw material for stock-feed purposes, as well as an important source of edible oil for human consumption. The quantity of oilseeds produced in South Africa is not sufficient to satisfy demand (Oilseed Board, 1993/1994) and therefore South Africa relies heavily on imports to supplement local production. Table 2.16 shows the domestic and import price of oilseeds. It is clear that South African oilseed producers have a competitive advantage over producers in other countries. Taking into account that South Africa is a net importer of oilseeds, domestic processors will benefit from increased local production of oilseeds.

Jooste et al (1995) calculated the long-term competitiveness of soybean and sunflower producers in South Africa. They concluded that no import tariff is necessary to protect producers in South Africa. This is also true for groundnuts. Increased productivity coupled with the deteriorating value of the Rand/Dollar exchange rate may further strengthen their competitive position.

During 1993, South Africa imported 468,323 tons of oilseeds and oilseeds products. This increased to 573,397 tons in 1994, valued on a CIF basis at R739.3 million.

The production of sunflower seed contributed to approximately 60 percent of the local demand of oil and oil-cake, while the rest was imported. Table 2.17 depicts prices and yields of sunflower seed for the past 10 years.

2.4.4 Sorghum

The demand for sorghum has increased over the past few years due to the utilization of alternative grain sources in the stock-feed market. The magnitude of the maize harvest usually has an impact on the prices and availability of sorghum. Table 2.18 shows the production of sorghum for the 1994/1995 season in all nine provinces.

2.4.5 Cotton

Table 2.19 shows that the Northern and Northern Cape Provinces contribute the most to cotton production. The latter obtains a relatively high yield due to irrigation.

2.4.6 Potatoes

The importance of the potato industry is reflected in its annual gross production value, which represents more than 4 percent of the total production value for all agricultural commodities and ranks the potato industry the tenth largest in the agricultural sector (1994).

In South Africa, potatoes are not a seasonal crop and is planted at different times in different regions, because of the difference in climate in the production areas. As was mentioned earlier, of the 85,000,000 hectares used for farming in South Africa only 13 percent (10,617,000 hectares) are being cultivated, of which 0.54 percent is being used for potato production.

2.4.7 Beef

Table 2.20 shows the availability of beef in South Africa, while Table 2.21 shows the per capita consumption of beef, mutton, pork and poultry. Per

capita consumption of beef declined over time, while per capita consumption of poultry increased.

Several aspects contributed to the decline in per capita consumption of red meat, particularly beef. According to Lubbe (1992), one of the major reasons was probably the failure of the red meat industry to adjust to changes in the socio-economic consumer environment. It particularly failed to compensate for the trend in urbanization, since it was designed primarily to serve the urban white consumer.

2.4.8 Mutton

Consumers' attitudes towards mutton in South Africa are particularly favorable because of its taste and tenderness. Rainfall plays a deciding role in the sheep industry. There is a definite relation between rainfall and the national herd size (Agrocon, 1995). Mutton prices are influenced by several factors, particularly the price of wool. The latter, in turn, is influenced by the declining exchange rate in South Africa.

Average commercial production (1990/1991 to 1993/1994) was 131,000 tons of lamb, mutton and goat meat, of which 93 percent is slaughtered in formal abattoirs. Non-commercial production for the same season was 37,000 tons (Meat Board, 1995). Historically, South Africa has been an importer of livestock and meat from neighbouring Namibia and Botswana. Average imports from these countries (1991 to 1994) were 16,000 tons for lamb, mutton and goat meat, of which 89 percent were slaughtered in South African abattoirs. Table 2.18 shows the overseas imports of beef, mutton and pork. Mutton exports were mainly to African countries, but exports of red meat were negligible relative to red meat availability in South Africa.

3. Methodology Used, Enterprise Budgets and Pricing Issues

3.1 INTRODUCTION

Since we do not live in a world of plenty, resources are limited. In essence, this implies that we have to allocate scarce resources to their best productive use. We need to find the optimal combination of resources through which the net benefit of the community can be maximized. However, governments have through various policies interfered with the optimal allocation of resources. The reasons for this interference is not the subject of this study and will thus not be pursued any further. The fact of the matter is that intervention in markets distorts prices of outputs and inputs. This, in turn, leads to market prices of goods and services in many cases not reflecting the particular good or service's actual value, i.e. the scarcity value.

The effective allocation of scarce resources is essential to maximize welfare. Since market prices in many cases do not reflect the scarcity value of resources, the calculation of shadow prices are essential in comparative economic analyzes. The general principle for the use of shadow prices is that it must only be used when the market price of goods and services do not reflect the scarcity value or economic contribution correctly. In other words, in circumstances where market prices of goods and services do not reflect their scarcity value or economic contribution due to, among other things, government intervention and market failure, they should be adjusted. Because of these reasons, both market and economic profitability analysis were conducted.

The rest of this chapter consists of three sections. First, methodological issues pertaining to DRC are discussed. Second, the determination of private prices and costs, and economic prices and costs are discussed, respectively (pricing of inputs and outputs; shadow prices, and the tradable/non-tradable composition of the value of inputs and products).

3.2 METHODOLOGY ISSUES

An important phenomenon that must be accounted for is that economic liberalization and regional integration drive the existing world trade patterns, and that this influenced the outcome of the Uruguay Round of GATT negotiations. Thus, countries are able to enlarge their markets by integrating their economies with those of neighboring countries. Some aim at trade liberalization, whilst others plan to integrate further and to establish common policies.

Chacholaides (1981) states that there are basically two approaches to international trade, namely the international approach and the regional approach. The international approach involves international conferences under the auspices of the General Agreement on Tariffs and Trade, now called the World Trade Organization (WTO). The regional approach involves agreements among a small number of nations whose purpose is to free trade among themselves, while maintaining barriers to trade with the rest of the world. The combined affect of these two approaches will have an influence on the comparative economic advantage of different countries and hence the pattern, direction and intensity of trade. De Rosa (1992) and Leamer (1984) state that welfare gains from regional versus multilateral trade are determined by the degree of compliment between resource endowments, institutional arrangements and the state of development of the physical infrastructure in countries forming the regional bloc. Gains from regional economic integration will be larger the greater the dissimilarity in the economic infrastructure and the resource base between the trading partners.

In order to exploit existing and potential trade opportunities efficiently, comparative advantage principles should guide economic policy reforms to direct

resources to their most productive use. Comparative economic advantage (CEA) analysis is the most common criterion used to evaluate economic efficiency in terms of social welfare gains from feasible alternative production options. The first step is to identify existing and potential opportunities for trade, that is options and activities of highest economic efficiency in the countries forming a potential trading bloc need to be examined and identified (Hassan and D'Silva, 1994).

CEA analysis evaluates the economic efficiency of alternative productive uses of scarce land, labor, capital and water resources within a particular country or region. It attempts to capture the interaction of national resources, production technology, product demand and government interventions (Masters, 1995). For any product to attract different resources, such as research, capital, etc, it must show a comparative advantage over alternative products that are available (Hassan and Faki, 1993). The option that generates the highest social gains from the use of domestic resources is considered the most efficient user of those resources. For any production option to be the most efficient user of a country's resources, two conditions need to be met. First, the foreign exchange cost of the domestically produced product must be less than its import price at the same foreign value, i.e. the cost of producing the product domestically must be less than the cost to import the same product. Secondly, the net foreign exchange gain from producing that product must exceed the net economic gain foregone from using the same amount of domestic resources to produce alternative products, i.e. the gains from using resources such as land, labor and water must be greater that the opportunity cost of using these resources in other production activities.

According to Hassan and Faki (1993), the Domestic Resource Cost (DRC) methodology provides the analytical tool for an empirical evaluation of economic efficiency among alternative enterprises. It is a commonly used criteria for measuring CEA. The concept of DRC relates to a measure of real opportunity cost in terms of total domestic resources of producing (or saving) a net marginal unit of foreign exchange (Bruno, 1967). The DRC method generates several measures of relative economic efficiency of production alternatives. It is used as an ex ante measure of comparative advantage to determine which among a set of alternative production activities is relatively efficient for a country or region in terms of contribution to national income (Bruno, 1967). Hassan and Faki (1993) used the following basic formula (Equation 3.1) to generate DRC ratios for Sudan:

where C_i measures the value of domestic resources used in saving or generating a unit value added in activity i; N_r is the opportunity cost of a unit of non-tradable primary factor r; X_{ri} is the quantity of factor r used in the activity i; P_j and Q_j are the import or export parity price and quantity of tradable product i; and R_j and Q_{ji} are the import or export parity price and quantity of tradable input *j* used in activity *i*. The denominator in the above-mentioned formula derives value added in activity i (VAD_i) and the numerator calculates the economic value or cost of domestic resources (CDRS) used to produce Q_i. When CDRS is expressed in local currency and VAD in foreign currency, C_i computes the DRC ratio for activity *i*. From this it is clear that the DRC analysis measures relative efficiency in terms of the cost in local currency of domestic resources required to save or to degenerate one unit of foreign exchange. This coefficient is then compared to the effective or parallel exchange rate, which entails that if:

$DRC_i < e$,

then the country has a comparative advantage in producing commodity I; but if:

$DRC_i > e$,

there is no comparative advantage. In other words, in the case of South Africa, it would cost more South African Rand (R) to produce one unit of commodity *i* locally than to buy the same unit abroad.

Results obtained from the DRC analyses offer information useful to policy makers in directing production and research resources to their most productive uses. It furthermore enables one to determine the contribution to net social gains and the economic efficiency of different competing crops under various policy and technological scenarios.

Table 3.1: Interpretation of RCRs

Value of RCR	Interpretation
0 < RCR < 1	Value of domestic resources used in producing is less than the value of foreign exchange earned or saved; thus there is a comparative advantage.
RCR > 1	Value of domestic resources used in production exceeds the value of foreign exchange earned / saved, thus no comparative advantage.
RCR < 0	More foreign exchange used in the production of the commodity than what the commodity is worth; thus there is a net loss of foreign exchange and no comparative advantage.

An alternative measure of economic efficiency that is easier to interpret is the resource cost ratio (RCR). Resource cost ratios provide an explicit indication of the efficiency with which production alternatives uses domestic resources to generate or save foreign exchange (Morris, 1990), thus serving as a relative indicator of the degree of efficiency. According to Morris (1990), the RSRs also lend itself more readily to cross-country comparison. The RCR is obtained when both the numerator and denominator in the above-mentioned formula are expressed in the same currency units. The RCR value is then interpreted as follows (Table 3.1):

According to Hassan and Faki (1993), the major difficulty that arises when using the DRC and RCR methods is the valuing of inputs and outputs, especially when choosing the appropriate opportunity cost of both non-tradables and tradables. This difficulty is mainly due to an absence of markets in the case of non-tradables and often the lack of correspondence of prices of tradables to their true economic value. Both methods therefore distinguish between social or economic and market (private) prices (Hassan and Faki, 1993). Nakhumwa et al (1994) mentions that it is important to note that DRC results can serve as basis for ranking enterprises in terms of current and expected future social profitability, as well as for segregating those enterprises that waste foreign exchange or domestic currency.

Hassan and D'Silva (1994) investigated the reasons for the importance of conducting CEA analysis within an agro-ecological framework. They concluded that agricultural production is primarily a biological process that is highly dependent on the prevailing biophysical conditions. Agricultural suitability reveals the similarity in natural resource endowments and production potential, and hence is complimentary with or competitive in trade between countries.

Table 3.2: Measures of Economic Efficiency and Policy Distortions

	Tradable			Non-tradable
	Products		**Inputs**	**Domestic Resources**
Value at market prices	MP		MR	Y
Value at social prices	P		R	
Policy effect (tax/subsidy)	MP-P		MR - R	N
Private profitability	PP	=	MP - MR - Y	Y - N
Social profitability	SP	=	P - R - Y	
Nominal protection ratio	NPR	=	MP/P	
Effective protection ratio	EPR	=	(MP - MR)/(P-R)	
Total net policy effect	NPE	=	PP - SP	
Value added	VAD	=	P - R	

In this study, RCR measures of CEA will be calculated for various commodity groupings in order to capture and analyze the impacts of the above-mentioned determinants. The following conventions will be adopted to group commodities according to the above factors:

As recommended by the Regional Trade Project's Steering Committee at the June 1995 in Pretoria, the agro-ecological zonation approach will be adopted as the framework for classifying production environments according to biophysical conditions.

Variations within agro-ecological zones (AEZ), due to variations in technology, tenure, etc., will be captured by coding different production systems as distinct activities.

Variations in market and infrastructural factors will be reflected in prices and transportation costs. These variations will be captured by defining a central market node for every zone at which all trade will be assumed to take place. Consequently, prices and transport costs between these market centers (nodes) will reflect the opportunity cost of producing a commodity locally versus importing it from another region/zone or from outside the country.

Variations in resource endowments will be reflected in the relative rental values of those resources in the different market centers.

Other measures used in this study to measure and identify economic efficiency and policy distortions are shown in Table 3.2. A comprehensive discussion on these measures can be found in Monke and Pearson (1989) and Masters (1995).

In order to derive the social or economic price of tradables and non-tradables, different statistical methods and techniques are used in the study. The conversion method and the tariff protection method are used to calculate the economic price of tradables. The conversion method entails that the world price of goods and services are determined and adjusted with the cost-insurance-and-freight component of imported goods and services, whilst the latter method is an indication of the percentage deviation of the domestic price from international prices. The buying power approach was used to calculate the economic value of the South African Rand. Economic prices of fuel and electricity were derived from other studies.

3.3 PRICING OF INPUTS AND OUTPUTS

3.3.1 Market Profitability

Farm prices for inputs and outputs differ in different regions in South Africa. It was therefore necessary to calculate the market profitability of each region. The main source of data to calculate market profitability is the COMBUD publication (COMBUD, 1994; 1997), which is published each year by the National Department of Agriculture and which contains data on production costs, fixed costs as well as yields and prices of produce. As already mentioned in Chapter 1, these budgets are, however, only compiled for commercial farmers in different regions.

3.3.2 Economic Profitability

Due to market failure and government intervention, market prices often do not reflect the scarcity value of goods and services. It is therefore necessary to calculate the economic price (shadow price) of goods and services. Bradfield (1993) gives an extensive explanation of the different theoretical methods that can be used to calculate different shadow prices. The methods examined by him include: opportunity cost, willingness to pay, the marginal cost method, domestic resource cost, effective tariff protection, world price model and linear programming. He concluded that the world price method is the most practical for the calculation of the shadow price of goods and services. Mullins (1992) states that this approach takes into account world prices of goods and services, especially with regard to those goods that are freely traded on international markets. There is, however, one issue which the world price method cannot address, namely the calculation of shadow prices for non-traded products and services.

In this study, cases where the world price approach could not be used, shadow prices were determined by the opportunity cost approach. The opportunity cost approach uses the production that is given up elsewhere, by withdrawing these inputs from alternative uses, as the

shadow prices of inputs. On the other hand, for the shadow prices of outputs, the additional incremental benefit achieved by undertaking the project, relative to the situation, had it not been undertaken, is used.

The calculation of shadow prices is rather complex and involves many considerations. The methods underlying each approach used for calculating shadow prices for different variables are discussed in the following section.

3.4 METHODOLOGIES FOLLOWED TO CALCULATE SHADOW PRICES IN SOUTH AFRICA

The calculation of shadow prices for different inputs and outputs involve two components: tradable goods and services, and non-tradable goods and services. Tradables and non-tradables have to be defined, since the basis for calculating the individual shadow prices are different.

Gittinger's (1982) definition for tradables that can be exported is FOB price> domestic price of production. Tradables that are imported is defined as follows: domestic price of production > CIF price. Dasguptha (1972) defines tradable goods and services as those goods or services that are, or can be, traded on international markets without the interference of governments, monopolies or other restrictive behavior. These definitions of tradables are essentially the same. They were subsequently used for purposes of identifying tradable variables in this study.

Non-tradable goods and services are defined by Gittinger (1982) as follows: CIF price > domestic cost of production > FOB price, i.e. the import price of a product or service is greater than the cost of domestic production, but the cost of domestic production is greater than the price of that product or service on the world market. Hansen (1978) defines non-tradable goods and services as those goods and services for which the production cost and international transport cost is too high to make exports profitable, but to low to justify imports. Again, these definitions of non-tradables are essentially similar. Hence, they were used for purposes of this study.

Since some products may have a comparative advantage as exports, but may not have a comparative advantage as substitutes for imports and visa versa, the question regarding when to use import or export parity in the calculation of the economic price of a commodity is an important consideration to take into account. In order to overcome this problem, one must determine whether a crop is mainly exported or imported. In the latter case, one will use the import parity price to calculate the economic price of that commodity. When a crop is, however, exported, two questions must be asked: does a crop has a comparative advantage as an export crop or does this crop serve as substitution for imports from overseas? In the former case, the export parity price is used, whilst in the latter case the import parity price is used. An example in South Africa is the case of maize. South Africa is a net exporter of maize, but maize is not primarily produced for the export market. One must, however, consider the effect of surpluses, in which case the export parity price can be used. For example, maize is produced mainly for consumption in the domestic market and serves as substitute for imported maize. In this case, one will use the import parity price to calculate the economic price of domestically produced maize.

Thus, the results of the CEA analysis will differ according to the parity price used. Depending on the magnitude of the difference, one can draw some important conclusions.

3.4.1 Shadow Pricing of Tradables

In this study, the world price approach was used to calculate shadow prices for tradable goods and services. This approach implicitly assumes that goods and services are relatively freely traded. When trade of goods and services are restricted or distorted by government restrictions, the international free market price of those goods and services are used as its shadow price. Different methods can be used to determine the world price, but only the methods used in this study are discussed below. The use of different methods is necessitated because information is not freely available for every good or service.

(1) Conversion method

The conversion method entails that the world price of goods and services are determined and adjusted with the cost-insurance-and-freight (CIF) component of imported goods and services (Ward and Deren, 1991). Two approaches can be followed in this regard. The first approach is used when information regarding transport cost and insurance is available to determine the price of imported goods and services. This approach is denoted by Equation 3.2:

$$CIFW_{ij} = (IntP_{ij} + TransC_{ij} + Ins_{ij}) \times ExhR_{ij}$$

where:

$CIFW_{ij}$ = Cost-insurance-freight-value of imports in domestic prices;
$IntP_{ij}$ = International market price in US $;
$TransC_{ij}$ = Transport cost;
Ins_{ij} = Insurance;
$ExhR_{ij}$ = Exchange rate in Rand/US$;
i = Product identification; and
j = Year.

The second approach is used when information regarding transport cost and insurance is not available. A transport-and-insurance cost factor is used to adjust the world price to reflect domestic prices of goods and services. The transport-and-insurance cost factor can be obtained from international publications, such as the International Financial Statistics Yearbook (IMF, 1986). This approach is denoted by Equation 3.3:

$$CIFW_{ij} = (IntP_{ij} \times (1 + TransF_{ij})) \times ExhR_{ij}$$

where:

$CIFW_{ij}$ = Cost-insurance-freight-value of imports in domestic prices;
$IntP_{ij}$ = International market price in US$;
$TransF_{ij}$ = Transport-and-insurance cost factor as percentage of cost;
i = Product identification; and
j = Year.

(2) Tariff Protection Method

According to Bradfield (1987), tariff protection rates are an indication of the percentage deviation of domestic prices from international prices. The shadow price calculation, using the tariff protection method, is denoted by Equation 3.4:

$$W_p = D_p / (1 + T_{pr})$$

where:

W_p = World price;

Table 3.3: Calculation of the Factor Adjustment Regarding the Shadow Price

Current pump price (cent/liter)	166.0
Minus: Taxes, customs, etc.	
- Fuel taxes (cent/liter)	53.4
- Custom and excise (cent/liter)	4.0
- Other charges(cent/liter)	2.7
Plus: Taxes that could be seen as user charges	
- Multilateral Motor Fund (MMF) (cent/liter)	5.8
- National Traffic Safety Council (NTSC) (cent/liter)	0.2
Transfer to national road fund (cent/liter)	17.3
Shadow price (cent/liter)	111.9
Factor adjustment from current market prices to shadow prices	
[111.9 cent/liter] / [166,0 cent/liter]	0.67

Source: Conningarth Consultants, 1995

D_p = Domestic price; and
T_{pr} = Tariff protection rate expressed as a percentage.

The assumption underlying this method is that the ad valorem duty represents the deviation between the domestic price and the world price.

(3) Shadow Pricing of Fuel

The shadow price of fuel is the pump price of fuel, minus levies and taxes that do not directly benefit the fuel consumer (Mullins, 1992). Conningarth Consultants (1995) calculated the shadow price for diesel for 1994. The calculation of the factor with which the diesel price is adjusted from market prices to shadow prices, is shown in Table 3.3.

Mullins (1992) did the same calculation for petrol and diesel in 1992. He obtained a similar factor for adjustment from current market prices to shadow prices. For purposes of this study, the factor adjustment from current market prices to shadow prices for diesel and petrol were assumed to be identical. All costs pertaining to diesel and/or petrol were adapted with this adjustment factor to give the shadow price.

3.4.2 Shadow Pricing of Non-Tradables

Production processes are characterized by the use of non-tradable goods. Labor, land and water are examples of non-tradables used in the production of agricultural commodities. For purposes of this study, electricity is also considered to be a non-tradable good. Although electricity is being supplied to neighboring countries, and a potential exists to expand regional power transfers, the scale of distribution is of such nature that not even all areas in South Africa have access to electricity. Therefore, electricity can be regarded as a non-tradable for at least the short to medium term.

(1) Labor

According to Mullins (1992), labor differs in many respects from other production factors. He mentions that factors exist in the labor market that result in labor wages not reflecting labor's relative scarcity. The existence of minimum wages, which is the result of pressure from trade unions or government policy, forces the wage above the marginal product of labor, and thus limits employment. This was, however, not the case for agriculture in 1994.

According to Bradfield (1987), a clear distinction between three types of labor must be made-namely, skilled labor, semi-skilled labor and unskilled labor. The conventional approach is, however, to distinguish only between skilled and unskilled labor.

Economic theory states that when there is no intervention in the labor market, the market wage will not diverge from the marginal productivity of labor. However, factors such as minimum wages, render the market wage rate to diverge from the marginal productivity of labor. Distortions in the labor market, which cause the price of labor to deviate from the marginal product, necessitate the calculation of shadow prices for labor. Harberger (1972) mentions that when the economy is characterized by under-employment and unemployment, the shadow price for labor needs to be calculated. Shadow wages should reflect the opportunity cost of labor (Van der Tak and Squire, 1989). Opportunity cost refers to that product of labor that is foregone in the economy due to labor being captured in a specific project, rather than an alternative one.

Unskilled Labor

In South Africa, the severe and persistent involuntary unemployment of unskilled workers is not a new phenomenon. According to Conningarth Consultants (1995), the employment of this labor will entail fewer or no opportunity costs. The classic position has been that unskilled labor should have a shadow wage of zero (Sassone and Schaffer, 1978) or close to zero (Dasgupta and Pearce, 1972). This is, however, unrealistic, since individuals will only work if there is some form of reward attached to the work, such as money, food, etc.

Bradfield (1993) calculated the shadow wage adjustment factors for different sectors in South Africa. For agriculture, this shadow wage adjustment factor is zero. This calculation was, however, based on the assumption that the average product in the agricultural sector is equal to the average wage in the agricultural sector. This assumption is not far fetched if it is taken into account that a minimum wage for agriculture has not yet been set.

Table 3.4: Shadow Price Factor for Electricity

Year	Marginal Cost of Electricity Production (c/Kwh)
1993	3.30
1994	3.41
1995	3.43
1996	3.35
1997	4.86
1998	5.73
1999	5.91
2000	6.00
2001	6.14
2002	6.46
2003	8.04
2004	8.25
2005	8.38
2006	9.58
2006 and beyond	9.58
Average Marginal Cost	7.55
Current average Cost (market price)	6.00
Shadow price factor (7.55/6.00)	1.26

Source: Conningarth Consultants (1995)

Conningarth Consultants (1995) state that it is suggested that if better information is lacking, the shadow wage of rural labor in slack season may be taken as roughly the equivalent of three kilograms of grain per day. Using this methodology, they calculated the shadow price adjustment factor for unskilled laborers in the agricultural sector to be 0.609.

The fact that small-scale farmers make use of family labor presented specific problems. The social opportunity cost of such labor can be calculated as the output foregone. Due to a lack of such data for small-scale farmers, only a regional average can be calculated, using the Gross Geographic Product by the economic active population in that region. This figure includes both the poorest and the richest people in a region, which obviously will provide an over-estimation of the opportunity cost of small-scale farming laborers.

The shadow wage adjustment factor for unskilled laborers used in this study was taken as 0.609, as suggested by Conningarth Consultants (1995). For reasons already mentioned it was decided to use the same shadow price adjustment factor for labor used in small-scale farming.

Skilled Labor

For purposes of the study, skilled agricultural workers are classified as those workers who can drive tractors or operate machinery. In contrast, unskilled laborers are those who cannot operate machinery or drive a tractor. It is furthermore assumed that skilled labor is in full employment, whilst this is not the case for unskilled labor. This means that the market wage rate for skilled labors closely approximates the social opportunity cost. The shadow wage adjustment factor for skilled labor used in this study is zero.

(2) Electricity

Electricity is mainly distributed by ESKOM in South Africa. Conningarth Consultants (1995), after extensive consultation with ESKOM, calculated the shadow selling

price of electricity in South Africa. For production of agricultural products, the price at which electricity is bought from ESKOM is important. Table 3.4 shows the calculation of the shadow electricity price factor.

3.4.3 Shadow pricing of the local currency (exchange rate)

(1) The Shadow Price of the South African Rand

When economic values are calculated, the question should always be asked whether the current exchange rate of a country is a true reflection of the scarcity of the particular currency. The earlier discussions showed clearly that the exchange rate of a country plays an integral role in calculating the economic value of domestically produced tradable goods and services. The price of any imported good and service is converted by means of an exchange rate to internal price levels (reference is made specifically to the conversion method discussed in the previous section).

The use of world prices necessitates methods to determine the international value of a country's internal exchange rate. Because up to 1995 South Africa had two exchange rates, the Commercial Rand and the Financial Rand and because the Reserve Bank enforces foreign exchange control measures, are indicative that the current value of the Rand is not a true reflection of its economic value. While there are several other measures that influence the exchange rate, such as short- and medium-term capital flows, government interference, etc., these are not pursued further for the purposes of this study.

In this study, the buying power parity (BPP) approach was used to calculate the economic value of the South African Rand. This method is also used by the Industrial Development Corporation of South Africa (IDC). According to Bradfield (1987), the BPP approach implies that changes in relative prices of a country's goods and services are reflected by changes in the exchange rate. This entails that relative price changes between countries are used to calculate the shadow exchange rate. Since it is common practice in South Africa to value the South African Rand against the US Dollar, the producer price index of the US was used to calculate the shadow exchange rate of the Rand. Equation (3.5) denotes the calculation of the shadow exchange rate, using BPP.

Table 3.5: Elasticities of Input Price Changes in Response to Exchange Rate Depreciation

Input category	1st quarter	2nd quarter	3rd quarter	4th quarter	Total
Tractors	-0.167	-0.328	-0.195	*	-0.690
Lorries	*	-0.171	-0.143	*	-0.314
Implements	*	-0.193	-0.150	*	-0.343
Irrigation equipment	*	-0.264	-0.444	*	-0.708
Building material	*	-0.201	-0.011	-0.090	-0.302
Fertilizer	*	-0.492	*	*	-0.492
Fuel	*	-0.698	*	*	-0.698
Packaging material	*	*	-0.632	*	-0.632
Maintenance	*	-0.171	-0.150	-0.127	-0.448
Rail freight	*	*	-0.408	*	-0.408

Notes: Percent change due to a 1 % change in exchange rate

* Insignificant at 5%.

Source: Liebenberg (1990)

$SE = (PI_{SA}/PI_{FC}) / E_{bj}$

where:

SE = Shadow exchange rate;

E_{bj} = Base year exchange rate;

PI_{SA} = Producer price index for South Africa; and

PI_{FC} = Producer price index for the USA.

Bradfield (1993) states that a practical problem in calculating the shadow exchange rate is the choice of a realistic base year. According to Bradfield, the base year must adhere to the following practical requirements:

- the economic growth rate must be stable or near to the long term growth rate of the economy;
- the balance of payments must be near equilibrium;
- there should not have been any major economic or political crisis in the world;
- there must be domestic political stability;
- international economics must be relatively stable;
- the rate of unemployment must not be excessively high; and
- the inflation rate must not deviate to much from the long term trend in inflation.

The only year which conforms to a large extent to these requirements is 1975 (Bradfield, 1993). This year was therefore also used as base year for calculating the economic value of the exchange rate in this study. The shadow exchange rate for South Africa was calculated to be R4.08 in 1994, and was hence used to calculate the economic value of tradables that were being traded internationally. The market exchange rate as reported by the Reserve Bank of South Africa was R3.54/US$. This entails that the South African Rand was overvalued with 20 percent in 1994. This value corresponds closely with the financial value of the Rand (international value) at the time, as well as the present value (1997) after markets have largely been liberalized.

(2) The Impact of a Change in the Exchange Rate on Tradable Goods

Changes in the exchange rate will have an affect on the prices of both tradable and non-tradable inputs on the domestic market. Although various inputs are being produced locally, prices of these are derived from the world price of comparable goods on the international market. Locally produced inputs also make use of ingredients that are imported.

The price of tradable inputs must therefore also be adjusted with the exchange rate. However, due to paucity in data, the same approach to value tradable output can not be used. In order to determine the impact of the exchange rate on tradable inputs, two scenarios were used:

- the economic price of tradable inputs are determined only by adjusting it for tariffs, and
- the economic price of tradable inputs are determined by adjusting it for tariffs and the over-valuation of the exchange rate.

It should be noted that changes in the exchange rate will also have an impact on the price of non-tradables. However, due to the complex nature of calculating the effect of exchange rate changes on non-tradables, and because this study uses different assumptions, the limited advantage of calculating the

Table 3.6: The Tradable/Non-tradable Composition of the Value of Inputs and Products

Item	Percent Traded	Percent Non-traded
Fertilizer and pesticides	80	20
Other purchased inputs	90	10
Fixed cost	95	5
Variable costs	50	50
Electricity	85	15
Contract services	95	5
Transport	60	40

elasticity coefficients for non-tradables is over-shadowed by the limitations of the assumptions.

Liebenberg (1990), using regression analysis, calculated the effect of changes in the exchange rate on the price of different input categories. Table 3.5 shows the percentage effect of a one percent change in the exchange rate on input prices.

Table 3.5 shows that a depreciation of 1 percent will lead to a increase of between 0.20 percent and 0.70 percent in the price of inputs. It is important to note that the impact of changes in the exchange rate influences input prices over a period. Van Zyl (1990), Jooste et al (1995) and Van Schalkwyk et al (1995) quantified the impact of changes in the exchange rate on input prices for different products. For example, the average production cost for maize was estimated to increase with approximately 4.68 percent if there was a depreciation of 10 percent in the exchange rate, production cost for wheat will increase with approximately 4.18 percent, and the increase for soybeans was estimated to be approximately 3.84 percent.

The methodology used above assumes that input and output quantities are kept constant at current levels of utilization and only prices are adjusted. According to Van Schalkwyk et al (1995), this method is not entirely correct, since producers may tend to substitute certain inputs when other inputs become either cheaper or more expensive relative to the other inputs. They concluded, however, that because of the paucity of elasticities of substitution and the limited marginal advantage it would offer relative to the difficulties involved in estimating these effects, constant quantity levels can be justified in particular applications. The result of changes in the exchange rate is reflected in the difference, if at all, in the RCR ratios of the two scenarios.

3.5 THE TRADABLE/NON-TRADABLE COMPOSITION OF THE VALUE OF INPUTS AND PRODUCTS

Bradfield (1993), after examining the input-output table of South Africa, states that most inputs used in the South African economy consist of tradable and non-tradable components. The following derivation can be made from this:

- the production of tradable goods and services require non-tradable inputs;
- the production of non-tradable goods and services require tradable inputs;
- tradable goods and services require tradable inputs; and
- non-tradable goods and services require non-tradable inputs.

The 1993 input-output table for South Africa was used to estimate the tradable/non-tradable composition of the value of inputs and products. This is shown in Table 3.6.

The tradable/non-tradable components for each of the items in Table 3.6 were subsequently used in the farm budgets to calculate the domestic resource cost for different products in each region.

3.6 SHADOW PRICES OF LAND AND WATER

Policies regarding land and water will have a major influence on the comparative advantage South Africa may hold over the production of agricultural products in other countries. These policies should be considered against this background. Not only will policies on land and water influence comparative advantage between countries, but also between regions in South Africa. One should expect changes in resource use if water tariffs in South Africa are inclusive of its scarcity value. The change in production patterns that can be expected if the latter is implemented will differ between regions. It may be relatively easy to substitute season crops with each other, but this will not be the case with long term crops, such as sub-tropical fruits and citrus. When implementing water tariffs inclusive of its scarcity value one should also consider the capital investment made in irrigation agriculture together with the greater price risk due to liberalization and deregulation. These policies should therefore be evaluated in the broader framework of the internationaliza-

tion of agriculture, taking into account domestic resource endowments. If policies regarding water and land do not take these factors into account, it may be detrimental to the economy as a whole, i.e. the effect on the balance of payments and Gross Domestic Product (GDP) must be accounted for. Policy makers must take into account the forward and backward linkages of agriculture with the rest of the economy, as well as the agriculture employment multiplier.

3.6.1 Shadow Price of Water

South Africa, like many other southern African countries, has scarce water resources. The average annual rainfall of South Africa is, for example, only 500 millimeter against a world average of 860 millimeter (Department of Water Affairs, 1995). Rainfall is furthermore poorly distributed geographically between regions (see annual mean rainfall map in Appendix A). Rainfall also varies to a great extent from year to year, with prolonged droughts followed by severe floods. According to the Department of Water Affairs (1995), groundwater is not abundant. Only about 5,400 million m^3 of water per annum may be obtained from groundwater in South Africa, compared to the total demand of water of 19,043 million m^3 in 1990.

Rainfall is crucial for maintaining available water resources. Rainfall will ultimately influence base flows and surface runoff. In addition, groundwater's role in supplying water should not be under estimated. The ability of soil to retain water is especially important with regard to agriculture. Since we have little or no control over the supply of water, it is of the utmost importance that we adjust our use of water accordingly.

According to the Department of Water Affairs (1995), irrigation agriculture accounted for more than 50 percent of water used in South Africa in 1980 and 1990. Hassan et al (1996) states that on average, irrigated agriculture uses about 100 percent more water per hectare than other agricultural sectors. According to them, dry land farming, forestry, and conservation rely entirely on rainfall, whereas irrigated agriculture withdraws about 75 percent of its water requirements from water stored in rivers and dams. Municipal, domestic, industrial and mining use of water contributed to 22.3 percent of total water use in 1990. It is thus clear that water use by agriculture will become more important in future.

Clearly, South Africa has no abundant supply of water. This is not reflected in water tariffs that have been paid by farmers in the past for the right to use water in agriculture. In most cases water tariffs do not even cover annual recurrent expenditure to provide water to agriculture. Hassan et al (1996) states that by recovering only the total financial costs of water supply, the tariff system assumes that water is in abundant supply to meet total demand by all users. If water is assumed not to be scarce, one assumes that it has no opportunity cost.

From the above it is, however, clear that water in South Africa is in limited supply. This implies that water will have a positive opportunity cost. This means that one unit of water used in one sector reduces the water available to be used in other sectors by one unit. The opportunity cost thus represents the scarcity value of water. However, since a free market for water does not exist in South Africa, the scarcity value of water must be approximated. Hassan et al (1996) calculated the scarcity value of water for dryland production to be R0.35 per m^3. In a more recent study Hassan and Van der Merwe (1997) estimated the scarcity value of water to be between R0.50 and R6.00 per m^3, depending on the particular catchment area. The results of the latter study were based on forestation and high value crops, such as subtropical fruit and citrus. Since this study does not account for these crops, the scarcity value of R0.35 per m^3 was used to reflect the opportunity cost of water in South Africa.

Presently, the tariff paid on the use of water is made up of operational cost, maintenance, capital redemption and improvements (or parts of these components). It does not include the scarcity value of water. Thus, in order to do a CEA analysis it is necessary to include both the tariff and the scarcity value of water, i.e. the tariff plus the scarcity value will give the economic (shadow) price of water. For purposes of this study, different tariffs applied to water from different water schemes was used on a Rand per hectare basis. The economic value of water was then calculated by adding the scarcity value of R0.35 per m^3. It was, however, necessary to convert the scarcity value of water from m^3 to mm/ha, since

water usage in agriculture is commonly measured in mm/ha.

3.6.2 Shadow Pricing of Land

Water aside, land is usually regarded as the scarcest resource in South Africa due to very distinguished characteristics (particularly high potential land). Land is non-reproducible nor can it be moved from one area to another. However, due to various policies in the past and different socio-economic values, land values tend not to reflect its true economic value to society in South Africa (see Van Schalkwyk and Van Zyl, 1997). The financial outcomes of various policy distortions were capitalized into higher land values, causing a wide gap between the market value of land and its actual productive value (opportunity cost).

Gittinger (1982) defined the economic cost of land (opportunity cost) as the net value of production forgone when the use of land is changed from its "without" use to its "with" use; measured in border prices. In the absence of a market value that reflects the opportunity cost to use land, Monke and Pearson (1986) state that the rental value can be used instead. For purposes of this study, rental values for land was calculated as 4 percent of the market value of land in different regions. This is consistent to the findings of Van Schalkwyk and Van Zyl (1996), which are summarized in Appendix A.

3.7 SUMMARY

The information in this chapter gives an indication of distortions in the input and output markets facing agriculture for both tradable and non-tradable products. The methodology described above was used for the construction of detailed enterprise budgets using market prices and costs, and economic prices and costs. The construction of these budgets is discussed in Chapter 5.

4. Agro-Ecological Zone Delineation

4.1 INTRODUCTION

In order to conduct the CEA analysis, South Africa was divided into six agro-ecological zones. This is in accordance to the unified approach adopted by the Steering Committee of the Regional Trade Project.

For the purpose of this study, the term 'agro-economical zone' is adopted. An agro-economical region can be defined as that area of land that through its physical, biological, economical and historical is characteristics more or less homogeneous. It is clear that the concept of agro-ecological regions investigated by Hassan and D'Silva (1993) is similar to the concept of agro-economical zones defined by the Department of Agriculture (1947). For this reason, the latter concept is used in the rest of this study, although it should be considered fully interchangeable with the former.

In general, it can be stated that although a number of factors may influence a certain region, only a few or only one will determine the dominant characteristics of a specific land area, mostly referred to as a region (Department of Agriculture, 1947). Van Schalkwyk and Groenewald (1994) state that productivity and costs determine comparative advantage. Moreover, two aspects are vital in this respect, namely natural factors and economic location.

In order to determine relatively homogeneous agro-economical zones, it is necessary to know which factors cause major differences between regions and make them suitable for the production of different commodities. Section 4.2 of this chapter discusses the different factors that determine different agro-economical zones. In Section 4.3 different agro-economical zones are derived, making use of the factors discussed in Section 4.2.

4.2 FACTORS DETERMINING AGRO-ECONOMICAL ZONE DELINEATION

According to the Department of Agriculture (1947), the most suitable form of farming for a specific place is mainly determined by:

- physical factors (topography, soil, climate and especially rainfall);
- biological factors (illnesses, pests);
- economic factors (market and transport facilities, production costs); and
- historical factors (traditional factors, etc).

None of these factors will be found in exactly the same ratio on any farm. Certain areas of South Africa are, however, to a lesser or to a greater extent suitable for certain crops or livestock. Such areas can usually be distinguished from neighboring areas due to certain characteristics or the specific nature of farming enterprises in that area.

4.2.1 Physical Factors

Physical factors include topography, temperature, rainfall and soil. These factors have important implications on decisions regarding what to produce. (See Appendix B for relevant maps of South Africa.)

(1) Topography

This concept refers to altitude and the gradient of soil. Altitude is a critical factor determining the nature of South Africa's climate, due to its specific location on earth. For example, even high-lying places at the northern border of South Africa are cooler in summer months and normally colder in winter months than

lower-lying areas in the south which has a sub-tropical climate (Department of Agriculture, 1947). Moreover, the proximity and direction of mountains may also influence rainfall in a region. For example, the Hexriver Mountains in the Western Cape and the Drakensberg Mountains, which stretches from the south of Kwazulu-Natal up to the Northern Province, greatly influence the nature of agriculture in South Africa.

The major part of South Africa comprises a geographically warped plateau at more than 1000 meters above sea level. The southern part of the plateau, which covers the most of South Africa, excluding the Northern Province, is tilted downwards to the east. The main river system of the south, the Orange River, flows westward while the long rivers of the north, such as the Limpopo, flow eastward (Department of Water Affairs, 1986). The relatively flat topography also gives rise to evaporation of scare water resources. In some instances, a specific topography coupled with low rainfall and insufficient vegetation cause severe erosion.

(2) Temperature

In South Africa, there is a relatively close relationship between temperature and topography. A characteristic applicable to the largest part of South Africa is the contrast between summer and winter.

Temperature does not only influence natural plant growth, but also the type of crops cultivated, and to a lesser extent the type of livestock that can be kept in a region. Temperature also influences the rate of evaporation. Higher temperatures are associated with higher evaporation, thus having a negative affect on availability of water. In the northwestern Cape Province, for example, evaporation exceeds rainfall by a factor of 25:1 (Department of Water Affairs, 1986).

(3) Rainfall

Rainfall is indisputably the strongest limiting natural factor in South African agriculture, especially with regard to crop cultivation (Department of Agriculture, 1947). Rainfall is distributed unevenly over the country, with humid subtropical conditions in the east and dry desert conditions in the west. Only a small percentage of South Africa receives a median annual rainfall of more than 1000mm. This area is mainly restricted to the eastern parts of the country. According to the Department of Water Affairs (1986), the factors that influence rainfall vary from region to region. At one extreme, there is the eastern-facing Drakensberg escarpment in Kwazulu-Natal, where moisture-laden air is often present and where several different rainfall-producing mechanisms exist. At the other extreme is the desert area of the northwestern Cape Province, where the air is hot and dry and the topography flat, and the main rainfall-producing mechanism is the occasional conventional thunderstorm.

The total annual rainfall is not of major importance, but rather the distribution, nature and certainty thereof. The amount of water that can be used efficiently is also of importance. Water that runs off or evaporates cannot be utilized efficiently. The Department of Environmental Affairs and Tourism states that water availability is the most crucial environmental resource for future development. The bulk of South Africa's available water is on the relatively steep eastern slopes of the Great Escarpment, where it is difficult to contain it before it reaches the sea unused. The inland plateau is relatively dry, particularly in the west. Around Cape Town, water is, however, relatively abundant due to local climatic conditions.

The southwestern coastal region of South Africa receives its rainfall during the winter months; the coastal region around George and Knysna receives more or less even rainfall during the year. The rest of South Africa, also known as the summer rainfall region, receives its rainfall during summer months.

Unlike temperature, rainfall has a big influence on both cropping practice and livestock farming in South Africa. Rainfall is a major determinant of natural vegetation in a region and hence also the type of livestock held.

(4) Soil

Soil does not only dictate if a region is suitable for cropping, but together with rainfall and temperature determines the nature of natural plant growth of a region. This in turn will influence the extent and nature of livestock farming. After rainfall, soil is the most

important factor determining farming systems in a particular region.

(5) Summary

Within this context, Van Schalkwyk (1992) calculated a resource quality index for South Africa. Factors that contributed significantly to the resource quality index include the stability of rainfall, irrigation and the percentage of land under natural pasture. The resource quality index can be divided into the following broad regions:

- Regions with lower-than-average resource quality: Northern Cape, Karoo, parts of the eastern Cape, south and southwest Free State and the Northern Province;
- Regions with average resource quality: Most of the maize regions which include the eastern and northern parts of the North West Province, western Mpumalanga, northern Natal, east and southeastern Free State;
- Regions with above-average resource quality: northwestern Free State, eastern Mpumalanga, Natal Midlands and southwestern Cape; and
- Regions with very high resource quality: isolated areas in Natal and the western Cape fruit regions.

4.2.2 Biological Factors

In a society where the majority of people are poor, the ability to produce food locally is very important to ensure a healthy nation. Failure to do so will result in expensive food imports from other regions. (See Appendix B for relevant maps of South Africa.)

(1) Plant Growth

Natural plant growth in South Africa consists mainly of grasslands, desert shrubs, tree overgrown grass prairies and woods. Plant growth is influenced mainly by physical factors, namely topography, rainfall and soil. Plant growth especially has a major influence on livestock farming.

(2) Pests and Diseases

Insect pests, plant and animal diseases and weeds affect agriculture through the damage that they cause. Some pests and diseases are common to most of South Africa, whereas certain pests and diseases are only found in certain regions. For example, foot-and-mouth disease limits the marketing and, therefore, the production of cattle in the northeastern parts of South Africa. This area is also more prone to other animal diseases than the rest of the country.

Some biological factors have a positive influence with regard to its contribution to agriculture. The development of new cultivars or varieties for specific conditions is a good example (Department of Agriculture, 1947). The potential to produce bio-mass is highest in the eastern part of the country. It gradually declines to the west, where it is low over virtually the whole of the Northern Cape Province. Small islands of high potential occur along the east coast and in the far north due to localized soil and climatic conditions. As a whole, however, South Africa has a relatively low potential to produce bio-mass.

4.2.3 Economic Factors

Natural factors set the conditions for production in a region, but does not directly determine the nature of specific farm enterprises in a region. Farmers will base their decisions on sound economic principle and direct scarce resources to their most productive use, i.e. farmers with profit maximization as their main objective will use that combination of inputs where the marginal cost is equal to the marginal revenue. Different regions are involved in the production of different commodities, which induces differences in relative prices among different regions. Nieuwoudt (1972) stated that different products involve different input mixes, and differences in price stability of different inputs have been documented.

Van Schalkwyk and Groenewald (1994) mentions that different regions are not equidistant from markets and are not equally well served by transport and marketing infrastructure. The transport network with regard to both road and rail will influence production practices and competitiveness. South Africa, compared to other southern African countries, has a well-developed and maintained road, railroad and aerodrome system. Changes in transport facilities can change the pattern, influence comparative advantage,

cause overlapping and change regional specialization (Tomek and Robinson, 1987).

Infrastructure is also well developed with regard to processing, manufacturing, communication and other important services. The developing sector or rural areas were to some extent neglected when it came to the development of infrastructure. With respect to the importance and nature of markets, the Von Thünens and subsequent models on location theory can be used to explain intensive-, semi-intensive and extensive farming.

Within this context, Van Schalkwyk and Groenewald (1994) calculated regional output/input price differentials and variations to evaluate price risk in South Africa. They found that price unstable regions are not necessarily also climatically risky regions, as regions with higher output/input price ratios can handle higher price variations better. Regions with higher resource quality also exhibit more favorable price ratios. Regions associated with high output/input price ratios largely appear to be close to large urban centers or along main traffic routes in addition to having high resource quality indices. (See Appendix B for relevant maps of South Africa.)

4.3 SOUTH AFRICAN AGRO-ECONOMICAL ZONE DELINEATION

Before the new (1995) constitutional dispensation, South Africa was divided into four provinces: Free State, Natal, Transvaal and the Cape Province. These provinces were formed based on political considerations more than on agro-economical considerations.

On the other hand, the Department of Agriculture divided South Africa into nine development regions. Some of these regions were to a certain extent homogeneous with regard to factors discussed in the previous section, for example the High Veld Region and Kwazulu-Natal. Other regions, however, are heterogeneous with respect to factors such as biological productivity, rainfall, etc., for example the Glen region stretched from the Western Free State to the Kalahari Desert. This aspect renders the Department of Agriculture's delineation not useful.

During the political reform process that started in 1992, South Africa was divided into nine provinces, closely following the Development Regions delineated and used by the Central Statistical Services in the 1980s. The establishment of the nine provinces is mainly due to political reform, rather than dividing South Africa into homogeneous regions. There is, for example, a large difference in the production capacity between the eastern Free State and the western Free State. The nine provinces could therefore not be used.

It appears that there is no ready delineation of South Africa into agro-economical regions that can be used readily for purposes of this study. The main purpose of this section is, therefore, to establish an agro-economical delineation for South Africa based on the earlier discussion. This can be used as basis for calculating RCRs in South Africa. By using this delineation, one will be able to characterize zones according to the factors mentioned in the previous section. Homogeneity of regions will therefore be of major importance. Agro-economical zonation with respect to the different factors will also provide a sound basis for comparing and evaluating comparative advantages between countries and regions within countries in the SADC region.

The main data sources used for the delineation of the different agro-economical zones were the GisLAB at the University of Pretoria, published documents by the Department of Environmental Affairs and Tourism, maps of the National Department of Agricultural and Enpnat 95. This information is mainly in a map format, which made the task of identifying different zones much easier. Maps used for the agro-economical delineation are shown in Appendix B, and include median and average annual rainfall, vegetation, erodibility, rivers, annual runoff (water availability), biological production, land use patterns, population per square kilometer, landscaping and average regional output/input price ratios. Other maps that were also used are not included due to their size. The Department of Agriculture in 1947 and 1967 published two maps that were of great. The usefulness of the first map (an agro-economical map), was limited by the fact that a large area has not been classified when published,

Table 4.1: Agro-Economical Zone Delineation for South Africa*

Factor	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Rainfall (mm)	200-800	0-400	400-600	0-600	1200-1400	600-800
Vegetation	Coastal tropical forest, Sclerephyllous bush	Karoo	Karoo, Grassland, tropical bush, savannah	Tropical bush, savannah	Grassland coastal tropical forest temperate, transitional forest	Grassland, topical bush savannah
Erodibility	7-20	7-14	7-20	7-20	1-6	7-20
Biological Productivity (t/ha)	1-3	0-1	3-6	0-3	6-10	6
Water Availability (runoff/m^3)	5000-20,000	<10000	10000-200,000	<10000-50,000	50000-200,000	<10,000-100,000
Resource Quality**	Average to very high	Below average	Below average to average	Mostly below average	Average to high	Average to above average
Output/ Input Price Ratio	Mostly low to average	Low	Mostly average to above average	Mostly low to average	Average to above average	Mostly above average

Notes: * Maps on the different criteria used are shown in Appendix B.
** Calculations regarding the resource quality index and output/input price ratios can found in Van Schalkwyk (1992) and Van Schalkwyk and Groenewald (1994).

whilst the second map was mainly based on agricultural economic considerations. Van Schalkwyk (1992) used the resource quality index and the agro-economical delineation of the Union of South Africa to identify five homogenous areas in South Africa. These areas can be divided into the Natal region, the cultivation areas, the Cape coastal region, Karoo and areas mainly suited for animal production.

The map on the following page shows the agro-economical zone delineation for South Africa according to the different factors mentioned, as used in this study.

It is important to note that some factors are the same between regions, for example the median annual rainfall in region 1 and 3 are approximately the same. There are, however, specific characteristics that distinguish these two regions from each other, such as the fact that the former receive its rainfall mainly during the winter, whilst the latter receive its rainfall during the summer months. The different zones identified

in this study are to a great extent similar to the zones identified by Van Schalkwyk (1992) and the Department of Agriculture (1947 and 1967). Table 4.1 shows the different characteristics of the different agro-economical zones in South Africa.

The different agro-economical zones in this study can be described as follows:

Zone 1: Cape Fold Region

The median rainfall ranges between 200 and 800mm per annum, whilst a very small portion receives a median rainfall higher than 1400mm per annum as seen from the rainfall map in Appendix B. Biological production, measured in tons per hectare, ranges between 1 and 3 tons. This zone's vegetation is mainly Sclerophylbus bush with temperate plus transitional forest near the coastal regions. Water availability (run-off in m^3 per square km) is, however, highly variable throughout the region. There is also great variability in erodibility within this region. As was mentioned, the main characteristic that distinguishes this zone from others is the fact that it receives its rainfall during the winter months. A part of the region receives more or less the same rainfall throughout the year. The largest area of this zone has above average resource quality. In contrast, only a small part of this region has above average output/input price ratios. The largest part has average output/input price ratios, while the southern parts in this zone has low output/input price ratios.

Zone 2: Nama Karoo Region

The largest part of Zone 2 has a median rainfall of 0 to 400 mm per annum. Biological productivity is very low in this region. Vegetation in this zone ranges from desert plants and grass to thorn bush. The largest part of this zone has high erodibility accompanied by very low water availability. This zone is characterized by poor natural resource quality and also experiences poor price ratios. Stability of prices are high within this zone, mainly due to its extensive farming enterprises (Van Schalkwyk and Groenewald, 1994).

Zone 3: Interior Region

Median rainfall in this zone ranges between 200 to greater than 1800mm per annum. The largest part of the zone, however, receives a median rainfall of 400 to 600mm per annum. Biological productivity ranges between 1 and 3 tons per hectare, with a small part having 6 tons per hectare. Water availability in this zone is relative low. Vegetation ranges from karoo to tropical bush and savannah. Erodibility is also very variable in this zone. This region is characterized by lower-than-average resource quality. The output/input price ratio varies from low to above average in this region, entailing variations from high to low risk. The largest part of this zone does, however, have average price ratios. This zone is characterized by high variability between the different criteria used.

Zone 4: Kalahari/Limpopo Plain Region

The median annual rainfall in this zone is relatively low. The western part receives a median rainfall of 0 to 200mm per annum. This increases to between 400 and 600mm per annum in the eastern part of this zone. Biological productivity shows similar trends. In the western part, biological productivity is low, while it increases to 3 tons per hectare in the eastern part of this zone. Vegetation in this zone is mainly tropical bush and savannah. Erodibility is relatively low throughout the region. The largest part of this zone is suitable mostly for cattle production, with scattered production of other crops such as maize. Water availability is relatively low in this zone. Resource quality in this zone is below average. Output/input price ratios in this region also show high variability, with the western parts having low price ratios and the eastern parts with average price ratios.

Zone 5: Eastern Plateau Slope/Lowveld Region

This zone has the highest median annual rainfall in South Africa. The largest part of this zone has a median rainfall of 1200 to 1400mm per annum. Biological productivity is also the highest in this region. The largest portion of this zone's vegetation is temperate and transitional forest, with tropical forest on the coastal regions and inland tropical forest in the north. Erodibility is highly variable in this zone. This zone is characterized by high water availability. Resource quality in this zone is above average, with isolated areas having very high resource quality. The largest part of this zone has average and above average output/input price

ratios, combined with high price stability, especially at the coastal regions.

Zone 6: High Veld Region

Approximately 90 percent of this zone has a median rainfall of 600 to 800mm per annum. Biological production capacity is relatively high, with only Zone 5 having higher biological productivity. Vegetation is overwhelmingly inland tropical forest, whilst erodibility is high. Water availability increases from the western part of the zone to the eastern part. The main cropping enterprises found in this region are maize, wheat and sunflower, whilst animal production includes cattle, sheep, etc. This zone has average resource quality. The largest part of this zone is characterized by above average output/input price ratios, coupled with stable prices.

From the above delineation, it is evident that there is high variability with regard to the different factors used. The western part of the country receives lower median annual rainfall, has lower biological productivity, and has lower water availability than the eastern part of the country. The changes in these factors do allow for identifying different zones.

5. Private and Economic Profitability

5.1 INTRODUCTION

In this chapter, the private and economic profitability of different zones, as identified in the previous section, are analyzed. On the one hand, the term 'private' refers to observed revenues and costs, reflecting actual market prices received or paid by farmers, traders or processors, and thus incorporates the underlying economic costs and valuations plus the effects of all policies and market failures. On the other hand, the term 'economic profits' measures the true economic value of goods and services by removing market and policy distortions. Valuations based on social prices measure comparative advantage or efficiency in an agricultural activity, since inputs and output are valued in prices that reflect scarcity values or social opportunity costs.

The total net policy effect (NPE) and effective protection coefficient (EPR), which are measures of policy distortions at the economic exchange rate, are also presented. (See Chapter 3 for the methodology used to calculate these policy measures.) The nominal protection ratio (NPR) indicates the impact of policy that causes a divergence between the market price and the social price of a commodity. The NPR on tradable outputs, in this case, indicates the degree of output transfer-for example, an NPR greater than one shows that policies were increasing the market price to a level higher than the social price. The effective policy coefficient (EPC), another indicator of incentives, is the ratio of value-added in private prices to value-added in world prices. This coefficient measures the degree of policy transfer from product market-output and tradable-input-policies. An EPC of higher than one (1.0) indicates that the private profit is higher than what it should have been without any commodity policies in place.

5.2 PRIVATE AND ECONOMIC PROFITABILITY

Within each of the six agro-economical zones identified in the previous chapter, a set of farming enterprises (commodities) was compared with regard to their private and social profitability. Enterprises/commodities were chosen on basis of their contribution to gross income in a specific zone. Various crops are being produced under dryland (rain-fed) conditions, as well as under irrigation. It was therefore decided to calculate private and economic profitability for both.

Moreover, more than 90 percent of the volume and more than 95 percent of the value of agricultural production is being produced by large-scale, commercial farmers in South Africa using modern, relatively intensive production methods that includes a large degree of mechanization. Data, as was indicated previously, are relatively freely available on these farming operations. However, data on mainly subsistence smallholder farming in the former homeland areas, which account for the rest of agricultural production, are virtually non-existent in South Africa. Information regarding smallholder cattle farming was, however, available and is included in the analysis. Large-scale, commercial farms are mainly privately owned, either by individuals or companies, and are operated accordingly.

Table 5.1 shows the different enterprises (commodities) analyzed in this study within the different agro-economical zones.

The commodities included in Table 5.1 are not the only ones that contribute to the agricultural gross income in the different zones. For example, the wine industry and other horticultural crops such as table grapes, apples and pears are main contributors to the agricultural gross income in Zone 1, while sugar,

Table 5.1: Enterprises Analyzed in Each Agro-Economical Zone

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Field crops and horticulture: dryland (rain-fed agriculture)					
Wheat	-	Maize	-	Wheat	Maize
		Wheat		Sorghum	Wheat
		Potato		Soybeans	Potatoes
		Sunflower		Cotton	Sunflower
		Cotton			Soybeans
Field crops and horticulture: irrigation					
Potatoes	-	Maize	Maize	Wheat	Maize
		Wheat	Cotton	Sorghum	Wheat
		Potatoes	Wheat	Soybeans	Tobacco
		Sunflower		Cotton	Sorghum
		Cotton			Soybeans
Livestock products					
Beef	Beef	Beef	Beef	Beef	Beef
Mutton	Mutton	Mutton	Mutton	Mutton	Mutton

which is also not included in the analysis, is the main contributor to the agricultural gross income in Zone 5. These products, however, do not fall within the scope of this study (as was decided by the Steering Committee of the Regional Trade Project).

The detailed enterprise budgets for all the commodities/products in each of the six zones are given in Appendices C and D (C for crops, D for livestock). The budgets form part of a large spreadsheet to facilitate easy analysis.

5.3 RESULTS

5.3.1 Field and Horticultural Crops

5.3.1.1 Large-Scale Commercial Farming

Table 5.2 presents the net private and economic returns to land and water for different agro-economical zones in South Africa for different field crops. Table 5.3 shows the net policy effect (NPE) and effective protection ratio (EPR) for the different crops in each agro-economical zone. (See Appendices C to E for details.) As mentioned earlier, NPE and EPR measure the impact of policy distortions on the different crops.

(1) Zone 1

Potatoes and wheat are the crops relevant in Zone 1. Zone 1 is one of the major wheat producing areas in South Africa. Production of wheat in Zone 1 has proven to be the most stable of all wheat producing areas in South Africa, both in quantity (yield) and quality. This makes Zone 1 an important source of wheat for millers over the country. It should, however, be taken into account that the largest demand for wheat exists in the northern part of South Africa, and in particular in the Gauteng Province. This entails that wheat must be transported to Gauteng by rail or road. Wheat produced in Zone 1 therefore has a locational disadvantage with regard to wheat producers in Zones 3, 4 and 5. In the regulated wheat market, this led to cross-subsidization of Zone 1 wheat producers. In the analysis provided here, the implicit assumption is that there are no other major field crops, such as maize and sorghum, which compete with wheat for land and water (apart from potatoes) in Zone 1. Animal feed grains, such as rye and barley, are being produced in

Table 5.2: Net Policy Effect and Effective Protection Ratio

Item	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Net Policy Effect (NPE)						
Maize – dryland			365.65	-117.35	304.94	
Maize – irrigation			808.84	27.82	-109.62	671.30
Wheat – dryland	159.69		796.01		257.61	714.59
Wheat – irrigation			1,312.52	1,396.18	1,933.97	522.98
Potatoes – dryland			5,344.00			2,674.50
Potatoes – irrigation	5,569.82		1,744.81			
Sunflower – dryland			251.64			398.94
Sunflower – irrigation			405.68			
Sorghum – dryland					241.18	
Sorghum – irrigation					70.18	421.67
Soybeans – dryland					12.25	-255.16
Soybeans - irrigation					913.67	-265.71
Cotton – dryland			2,145.84		423.16	
Cotton – irrigation				2,345.96	927.47	
Tobacco – irrigation						5,615.66
Net economic returns to land and water (R/ha)						
Maize – dryland*			179.92		-277.54	143.12
Maize – irrigation*			104.78	-537.62	-483.29	-207.16
Maize – dryland**			802.93		376.61	674.81
Maize – irrigation**			1,927.21	1,137.04	563.35	1,705.72
Wheat – dryland	424.30		1,030.46		394.34	1,186.27
Wheat – irrigation			2,139.09	2,434.29	2,056.31	1,216.62
Potatoes – dryland			5,656.77			3,154.75
Potatoes – irrigation	5,816.28		18,115.85			
Sunflower – dryland			1,039.77			1,229.05
Sunflower – irrigation			2,003.67			
Sorghum – dryland					1,279.77	
Sorghum – irrigation					1,574.42	1,236.40
Soybeans – dryland					386.23	839.00
Soybeans - irrigation					1,587.66	762.54
Cotton – dryland			2,299.27		864.33	
Cotton – irrigation					2,901.80	1,484.71
Tobacco – irrigation						6,467.97

Notes: * Maize is regarded as an export crop (export parity price)

** Maize regarded as an import substitution crop (import parity price)

Zone 1, but on a much smaller scale than wheat. These feed grains are also primarily used in Zone 1 for cattle and sheep farming.

The results in Table 5.2 show that for wheat and potatoes economic returns are higher than private returns. Thus, should the true economic value of inputs and outputs prevail in the market, farmers would receive higher returns. This is confirmed by the NPE and EPR results shown in Table 5.3. In the case of wheat, the large difference between private and

Table 5.3: Net Policy Effect and Effective Protection Ratio

Item	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Net policy effect (NPE)						
Maize – dryland*			185.74		160.19	161.82
Maize – irrigation*			704.05	565.45	373.67	878.46
Maize – dryland**			-455.27		-493.96	-369.87
Maize – irrigation**			-1,117.38	-1,109.21	-672.97	-1,034.42
Wheat – dryland	-264.61		-234.45		-136.74	-471.68
Wheat – irrigation			-826.57	-1,038.11	-122.34	-693.64
Potatoes – dryland			-312.76			-480.24
Potatoes – irrigation	-246.46		-668.04			
Sunflower – dryland			-789.14			-830.11
Sunflower – irrigation			-1,597.99			
Sorghum – dryland					-1,038.59	
Sorghum – irrigation					-1,509.24	-814.73
Soybeans – dryland					-373.98	-1,094.16
Soybeans - irrigation					-673.98	-1,028.25
Cotton – dryland			-153.32		-441.17	
Cotton – irrigation				-555.84	-557.24	
Tobacco – irrigation						-852.30
Effective protection ratio (EPR)						
Maize – dryland*			1.52		1.61	1.49
Maize – irrigation*			2.38	4.78	2.02	3.41
Maize – dryland**			0.56		0.49	0.59
Maize – irrigation**			0.54	0.46	0.54	0.55
Wheat – dryland	0.64		0.80		0.83	0.70
Wheat – irrigation			0.70	0.69	0.96	0.67
Potatoes – dryland			0.97			0.91
Potatoes – irrigation	1.00		0.98			
Sunflower – dryland			0.33			0.40
Sunflower – irrigation			0.34			
Sorghum – dryland					0.41	
Sorghum – irrigation					0.34	0.42
Soybeans – dryland					0.50	0.19
Soybeans - irrigation					0.68	0.21
Cotton – dryland			0.97		0.93	
Cotton – irrigation				0.95	0.99	
Tobacco – irrigation						0.97

Notes: * Maize is regarded as an export crop (export parity price)

** Maize regarded as an import substitution crop (import parity price)

economic returns was caused by the international-domestic price differential. One of the major factors contributing to the price differential is the Rand/Dollar exchange rate.[1] The other factor is the statutory fixing of the domestic wheat price between producers and millers (at the farm gate). Distortions in the input side were primarily caused by tariffs on imports of inputs, partly to protect domestic industries, which resulted in higher domestic prices for inputs. However, these tariffs are generally lower when compared to tariffs levied on input imports in the 1980s. Moreover, it should be taken into account that input prices are also influenced by changes in the exchange rate, thus contributing to the difference in private and economic returns.

The question that must, however, be asked is to what extent do input prices contribute to market distortions. The relatively small difference between the private and economic returns on potatoes is an indication that inputs are a relatively small source of market distortions, although tariffs are levied on different inputs. The level of these tariffs is relatively low.

(2) Zone 3

Maize (dryland and irrigated), wheat (dryland and irrigated), potatoes (dryland and irrigated), sunflower (dryland and irrigated) and cotton (dryland) were investigated in Zone 3. Table 5.2 shows that all the crops yield positive market and economic profitability results. Potatoes have the largest market and economic profitability. It must, however, be remembered that the area used for potato production is limited due to factors such as labor intensity and availability of water. Economic profitability for all the crops, except maize as export crop, is higher than the private profitability, with sunflowers showing the highest increase from private to economic profitability.

The positive sign of the NPE for maize, as export crop, and the negative sign of the NPE for the other crops in Table 5.3 indicate that maize that is exported is subsidized, while the other crops are effectively taxed. The subsidy on maize that is exported can be explained by the fact that producer levies are used to finance export losses occurred on maize exports within a pan-territorial pricing system. The EPR is lower than unity for all crops, except maize as an export crop, also indicating that producers of these crops are taxed.

The international-domestic price differential, together with the Rand/Dollar exchange rate, is the major contributors to the difference between private and economic returns. This emphasizes the sensitivity of locally produced crops for changes in the international price and the Rand/Dollar exchange rate. The market distortions caused by input prices are relatively small, mainly due to relatively low tariffs on the imports of inputs. The change in the total costs of inputs, when expressed in economic terms, is less than 15 percent. (The effect of the exchange rate on input prices not taken into account.) The subsidy on electricity and tax on fuel are the main contributors to the market distortions on the input side.

(3) Zone 4

Zone 4 is primarily a livestock producing area, more particularly beef. This zone, however, includes the Orange River irrigation scheme, where some field crops are produced. This comprises only a small percentage of the total area of Zone 4. Table 5.2 shows the private and social profitability of maize, cotton and wheat under irrigation. For maize that is exported, the private profitability is higher than the social profitability, whereas this is the opposite in the case of maize regarded as import substitute, cotton and wheat. The NPE and EPR results in Table 5.3 show the extent of the distortions between private and economic profitability.

The international-domestic price differential, as well as the Rand/Dollar exchange rate, can be blamed for causing the largest market distortions. For example, in the cases where the private price is similar or close to the economic price, market distortions are small (as indicated by the close to unity value of the EPRs of potatoes in Zones 1 and 3, and cotton in Zone 4). This again shows that, although input prices are distorted by subsidies and tariffs, inputs can not be regarded as the major contributors to market distortions.

1 Exchange rates have since been liberalized to some extent.

(4) Zone 5

Net private and economic returns to land and water for each crop cultivated in Zone 5 are shown in Table 5.2. The relative profitability of maize, wheat, sorghum, soybeans and cotton (dryland and irrigation for each) were calculated.

From Table 5.2 it is evident that with regard to private profitability, wheat under irrigation dominates the other field crops. This is also the case when economic profitability is compared between the different crops. It should, however, be noted that the economic profitability of the other crops, in some cases more than doubled, for example sorghum, soybeans (dryland) and cotton (dryland). The increase from the private to economic profitability of wheat was only marginal.

Table 5.3. shows that producers of wheat, sorghum, soybeans and cotton were heavily taxed. Sorghum producers in Zone 5, for example, paid an implicit tax of more than a R1,000.00 per hectare. Similar conclusions regarding the international-domestic price differential, the Rand/Dollar exchange rate and input prices can be made as in the zones already discussed above.

(5) Zone 6

The analysis of Zone 6 includes maize (dryland and irrigated), wheat (dryland and irrigated), potatoes (dryland), tobacco (irrigated), sunflower (dryland), sorghum (irrigated) and soybeans (dryland and irrigated). The results, which are shown in Table 5.2, show that soybeans have a negative private profitability. Economic prices for soybeans are, however, positive, indicating that soybean producers are heavily taxed in Zone 6. The policy distortion measures confirm that maize that is exported is subsidized, while producers of the other products, including maize as import substitute, are taxed.

Similar to the conclusions made with respect to the other zones discussed above, the international-domestic price differential and the Rand/Dollar exchange rate are the major contributors to these distortions.

5.3.1.2 Small Scale Farming

Although small scale farming in South Africa is relatively small compared to commercial agriculture, it provides or contributes toward a livelihood for nearly a million families. This sector is not as sophisticated as the commercial agricultural sector, but research has shown that given the restriction in small scale farming, these farmers make rational decisions. This sector will play an important role in the fulfillment of government's food security policy in future. It is for this reason that various changes in policy to facilitate the development of this sector have been implemented. This sector should therefore also be investigated with regard to comparative advantages.

Small-scale farming can be divided into smallholder (in the process of becoming commercial) and subsistence farming. The former produces agricultural products to be sold in the market place to generate

Table 5.4: Net Policy Effects and Effective Protection Ratios for Small Scale Farming

Item	Zone 3		Zone 6	
	Smallholder	Subsistence	Smallholder	Subsistence
Market price	-38.69	-38.69	181.10	181.10
Economic price*	342.15	2,139.11	552.25	3,077.32
Economic price**	272.80	2,069.76	477.38	3,002.45
NPE	-380.84	-2,177.80	-371.15	-2,896,22
EPR	0.44	0.11	0.58	0.15
RCR*	3.87	0.26	3.96	0.25
RCR**	4.15	0.37	4.19	0.24

Note: * Input prices not adjusted for exchange rate

** Input prices adjusted for exchange rate

income for the purchase of other goods. The latter, however, is at that stage of development where food is produced for own consumption only. In reality, however, smallholder families both sell and consume agricultural products they produce. This entails that there are different values attached to the products that they produce. It means that the economic value that subsistence farmers attach to their produce will be larger than what smallholder farmers attach to their produce.

CEA analysis was subsequently also done for small-scale farming in South Africa in Zones 3 and 6 with regard to maize, the dominant crop produced by this sector. Table 3.4 shows the result from the CEA analysis. At market price level, small-scale farming has negative net returns in Zone 3 and positive returns in Zone 6. At economic price level both has positive net returns. It should be noted that with regard to smallholder farming, maize was regarded as an import substitute. The import parity price of maize was therefore used to calculate economic returns. In the case of subsistence farming the opportunity cost to purchase the final product for consumption was

Table 5.5: Net Private and Economic Returns to Land and Water for Beef Cattle and Sheep

Item	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Net private returns to land and water (R/ha)						
Beef:						
Commercial	61.46		70.94	17.71	59.17	16.09
Small scale			39.87	17.78	26.69	
Sheep:						
Extensive	202.95	45.32	74.21	32.60	85.10	108.14
Intensive			224.62			
Net economic returns to land and water (R/ha)						
Beef:						
Commercial	75.95		75.09	20.60	64.32	20.58
Small scale			42.17	18.70	29.62	
Sheep:						
Extensive	205.53	47.79	81.18	34.39	88.07	110.08
Intensive			233.33			
Net policy effect (NPE)						
Beef:						
Commercial	-14.49		-4.15	-2.90	-5.15	-2.90
Small scale			-2.31	-0.93	-2.93	
Sheep:						
Extensive	-2.59	-2.48	-6.97	-1.80	-2.97	-1.93
Intensive			-8.71			
Effective protection ratio (EPR)						
Beef:						
Commercial	0.95		0.95	0.89	0.95	0.89
Small scale			0.95	0.95	0.95	
Sheep:						
Extensive	0.99	0.96	0.93	0.96	0.97	0.99
Intensive			0.93			

Table 5.6: Resource Cost Ratios for Different Field Crops in Zone 1

Item	Wheat (Dryland)	Potatoes (Irrigation)
RCR*	8.70	0.44
RCR**	7.47	0.52

Notes: * Input prices not adjusted for exchange rate
** Input prices adjusted for exchange rate

used to calculate economic returns. The opportunity cost for subsistence farmers is the net cash outflow to purchase the final product (maize meal) if they did not produce it themselves.

The NPR and EPR results indicate that there are market distortions. These distortions have already been discussed in previous sections.

5.3.2 Livestock

The private and economic profitability of beef for the different zones derived in Chapter 4 are shown in Table 5.5. The positive private profitability in all regions is an indication of the profitability of beef productivity. This would suggest expansion, unless the farming area can not be expanded or substitute livestock products are more privately competitive.

5.3.2.1 Beef Cattle

Zone 3 shows the highest private profitability for commercial beef production, followed by Zones 1 and 5. Small-scale beef production in Zone 5 has the highest private profitability. Both commercial and small-scale beef production show positive economic profitability in all the zones. Economic profitability for commercial beef producers in Zone 1 producers is the highest, followed by Zone 3. The fact that economic profitability is higher than private profitability in all zones is an indication of market distortions (effective taxation of producers).

The reigning policy distortions prevailing in the beef market are confirmed by the negative sign of the NPE measure, as well as the lower that unity value of the EPR. Thus, policies influencing the beef sector in South Africa influenced producer prices of beef farmers negatively. The floor price system operated by the Meat Board also contributed to market distortions, and in fact influenced beef produced prices negatively (Venter, 1996). As was the case for field crops, distortions on the input side is minimal. The difference between private and economic input prices is less than 10 percent.

5.3.2.2 Sheep

Intensive sheep farming in Zone 3 is the most profitable. If one, however, compares only extensive sheep farming, Zone 1 has the highest private and economic returns to land and water, followed by Zone 6. The negative NPE's and lower than one (1.0) EPR's confirm the policy distortions in the sheep industry. These are, however, small.

5.4 THE DOMESTIC RESOURCE COST ANALYSIS

When systems are compared for relative efficiency, the domestic resource cost ratio (DRC), serves as a proxy measure for social profits. If the ratio equals one (1.0), then its analogous profitability measure equals zero (0). Minimizing the DRC is thus equivalent to maximizing social profits, implying that the lower the DRC gets, the higher the comparative advantage in producing that commodity.

In this section, the comparative advantage of one product over another was calculated by using the resource cost ratio (RCR). This method of calculation has already been discussed in Chapter 3. RCRs were calculated for each agro-economical zone derived in Chapter 4.

Since land and water are the limiting factors of production in South Africa, net social returns to land

Table 5.7: Resource Cost Ratios for Different Field Crops in Zone 3

Maize (export)		Maize (imp. subst.)		Wheat		Potatoes		Sunflowers		Cotton
Dry	Irr.	Dry	Irr.	Dry	Irr.	Dry	Irr.	Dry	Irr.	Dry
				RCR - Including Potatoes*						
48.47	34.72	17.98	7.87	16.04	7.01	2.93	0.42	15.67	7.90	6.24
				RCR - Exchange Potatoes*						
6.61	5.10	2.45	1.16	2.12	1.06	0.49	0.26	2.09	1.12	0.94
				RCR - Including Potatoes**						
55.43	56.52	18.61	8.23	15.71	7.35	2.90	0.27	15.45	7.80	6.48
				RCR - Excluding Potatoes**						
7.10	7.91	2.33	1.15	1.93	1.06	0.47	0.27	1.92	1.05	0.95

Notes: * Input prices not adjusted for exchange rate
** Input prices adjusted for exchange rate

and water in the best production alternative were used to determine the opportunity cost of producing alternative crops.

5.4.1 Field Crops

5.4.1.1 Commercial Farming

The first set of calculated RCRs in each zone in the subsequent tables does not account for the difference in the private and economic value of the Rand on input prices. The reason for this can be derived from the fact that changes in the exchange rate have a lagged effect on input prices (see Liebenberg, 1990). The second set of RCRs does, however, account for the difference between the private and economic value of the Rand on input costs.

(1) Zone 1

From Table 5.6 it is evident that potatoes have a comparative advantage over wheat. This was to be expected, since potatoes are irrigated whereas wheat is cultivated under dryland conditions. It must, however, be remembered that wheat is the main field crop produced in Zone 1, mainly due to climate and physical factors, which favor the production of wheat over other field crops. Potatoes are only found in certain areas, and therefore potatoes cannot be really be regarded as a substitute for wheat production.

Horticultural crops, such as apples, pears and table grapes, are not included in this study, but may prove to have a comparative advantage over wheat and

Table 5.8: Resource Cost Ratios for Different Field Crops in Zone 4

Maize (export)	Maize (imp. subst)	Cotton	Wheat
Irrigation	Irrigation	Irrigation	Irrigation
	RCR*		
20.38	1.96	0.90	1.16
	RCR**		
115.05	2.07	0.89	1.19

Notes: * Input prices not adjusted for exchange rate
** Input prices adjusted for exchange rate

Table 5.9: Resource Cost Ratios for Different Field Crops in Zone 5

Wheat		Maize (imp. subst.)		Sorghum		Soyabeans		Cotton	
Dry	Irr.	Dry	Irr.	Dry	Irr.	Dry	Irr.	Dry	Irr.
					RCR*				
3.27	0.83	2.79	2.05	1.45	1.21	3.30	1.22	1.71	1.24
					RCR**				
3.42	0.84	2.97	2.20	1.41	1.24	3.42	1.21	1.64	1.23

Notes: * Input prices not adjusted for exchange rate
** Input prices adjusted for exchange rate

potatoes. Note, however, that these horticultural crops are bounded to specific areas within Zone 1.

(2) Zone 3

Table 5.7 shows the RCRs for the different crops cultivated in Zone 3. Maize, wheat, potatoes, sunflower and cotton are all competing for the available land and water. The RCR for potatoes under irrigation shows its dominance over the other crops. It must, however, be remembered that the cultivation of potatoes is limited because of its high demand for labor, as well as due to climate and physical factors. It was therefore decided to calculate the RCRs for the different crops again by using two scenarios, one where potatoes are exclude and one where potatoes are included. The results show that all options, other than cotton under irrigation, are inefficient. The dominance of cotton over irrigated wheat is, however, weak when the small margin of efficiency between the RCR of 0.94 for cotton (irrigated) and 1.06 for wheat (irrigated) is considered.

The effect of the exchange rate of the Rand against the US Dollar on input prices has not significantly influenced the RCRs calculated. This may be attributed to the fact that the effect of a depreciation of the Rand is a lagged one, whilst the effect of a depreciation of the Rand influences the price of imported agricultural products immediately.

Table 5.10: Resource Cost Ratio for Different Field Crops in Zone 6

Maize (export)		Maize (import)		Wheat		Pota-toes	Tobac-co	Sun-flower	Sor-ghum	Soya-beans	
Dry	Irr.	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr.
						RCR – including tobacco and potatoes*					
19.12	19.09	7.58	3.08	5.16	3.68	1.75	0.66	4.85	4.77	5.26	5.48
						RCR- including potatoes and excluding tobacco*					
9.63	10.10	3.82	1.63	2.55	1.98	0.69	0.66	2.41	2.38	2.75	2.87
						RCR- excluding potatoes and tobacco					
4.13	4.89	2.17	0.79	1.41	1.24	0.69	0.52	1.35	1.34	1.66	1.73
						RCR – including tobacco and potatoes**					
21.01	28.84	7.49	3.06	4.88	3.83	1.92	0.63	4.66	4.54	5.31	5.81
						RCR- including potatoes and excluding tobacco**					
9.06	13.37	3.23	1.42	2.05	1.83	0.78	0.63	1.98	1.93	2.43	2.66
						RCR- excluding potatoes and tobacco**					
4.78	7.83	2.13	0.83	1.31	1.31	0.78	0.54	1.29	1.26	1.68	1.84

Table 5.11: RCRs for Small-scale Farming

Item	Zone 3		Zone 6	
	Smallholder	Subsistence	Smallholder	Subsistence
RCR*	3.87	0.26	3.96	0.25
RCR**	4.15	0.37	4.19	0.24

Note: * Input prices not adjusted for exchange rate
** Input prices adjusted for exchange rate

(3) Zone 4

Three crops were investigated in Zone 4, namely, maize, cotton and wheat. All three crops are cultivated under irrigation. Therefore, it is important to note that the cultivation of these crops is limited to the availability of irrigation water. The RCRs in Table 5.8 indicate that cotton dominates maize and wheat production, but that the dominance is weak.

As in Zone 3, the exchange rate of the Rand against the US Dollar did not influence the dominance of cotton over the other products. A further reason for this is the fact that the input combination of the different crops does not differ much, although the different crops do not use the same type of inputs as those that fall within the same category.

(4) Zone 5

In Zone 5, wheat, sorghum, soybeans and cotton are competing for resources. Table 5.9 shows the calculated RCRs for the different crops in Zone 5.

Table 5.9 shows that wheat under irrigation dominates all the other crops. Further investigation of the RCRs show that irrigated crops dominate dryland crops. This is reflected in the large difference between the RCRs of the irrigated crops and the dryland crops. The availability of water thus plays a crucial role in the dominance of one cultivation practice over another. The dominance of irrigated wheat over irrigated sorghum, soybeans and cotton is relatively weak. This is reflected in the small difference in the respective RCRs that were calculated.

The different field crops in Zone 5 also proved to be insensitive to the Rand/Dollar exchange rate on inputs used to cultivate the different crops. In some cases, the RCRs moved closer to unity and in other cases the RCRs worsened. This is a direct effect of different usage of inputs, but again the changes in the RCRs are marginal.

(5) Zone 6

The calculated RCRs for Zone 6 are shown in Table 5.10. When the opportunity cost of land and water is used to produce the most profitable alternative (tobacco), all other options are inefficient.

Table 5.12: Resource Cost Ratios for Beef Cattle

Zone 1	Zone 3		Zone 4		Zone 5		Zone 6
Commercial	Commercial	Small scale	Commercial	Small scale	Commercial	Small scale	Commercial
			RCR*				
0.99	1.01	1.70	3.15	3.84	1.11	1.88	2.89
			RCR**				
0.98	1.01	1.69	3.30	3.79	1.14	1.94	2.95

Notes: * Input prices not adjusted for exchange rate
** Input prices adjusted for exchange rate

Table 5.13: Resource Cost Ratios for Sheep in Different Zones

Item	Zone 1 extensive	Zone 2 extensive	Zone 3 semi-extensive	Zone 3 extensive	Zone 4 extensive	Zone 5 extensive	Zone 6 extensive
RCR*	1.12	4.59	0.89	2.58	6.00	5.54	1.93
RCR* extensive	0.58	4.05	0.52	2.29	5.30	2.25	1.72
RCR**	1.11	4.53	0.90	2.57	5.94	2.51	1.93
RCR** extensive	0.58	4.04	0.53	2.30	5.30	2.24	1.73

Notes: * Input prices not adjusted for exchange rate

The production of tobacco is, however, very limited because of climate and biological factors. The RCRs were again also calculated after omitting tobacco from the equation. This time, potatoes proved to be the most efficient crop, but to reasons already mentioned, the production of potatoes is also limited. It was therefore necessary to calculate another set of RCRs for Zone 6 where both these commodities are omitted. When tobacco and potatoes are both omitted from the equation, maize that serves as import substitute, is the most efficient crop. The RCRs for wheat (dryland and irrigation) and sunflowers (dryland) are marginally higher than the RCR for sorghum (irrigation). Sunflower is the most efficient crop under dryland conditions.

The increase in input prices due to depreciation of the Rand/Dollar exchange rate again influenced the RCRs only marginally. This is an indication that the effect of a rise in input costs due to a depreciation of the Rand is basically uniform over the range of products investigated.

5.4.1.2 Small-Scale Farming

The RCR results in Table 5.11 show that subsistence farming has a comparative advantage over smallholder farming. They also illustrate the need and social benefit of supporting subsistence farmers. Smallholder farmers produce maize to generate income for the purchase of other consumables to improve their livelihood. Subsistence farmers on the other hand produce maize for consumption since there is no other revenue source to purchase food and other consumables

5.4.2 Livestock

(1) Beef

Table 5.12 shows the RCRs for beef in different regions. Zone 1 has a comparative advantage over the other regions. Its dominance is, however, small compared to Zone 3. If one take into account that Zone 3 is closer to the largest consumption area of beef (Gauteng Province), it can be concluded that beef that is being produced in Zone 3 will be more competitive in Gauteng than beef being produced in Zone 1.

Table 5.14: The Effect of the Cost of Land and Water on Efficiency in Zone 1

Description	Wheat Dryland	Potatoes Irrigation
RCR (from section 5.4)	7.47	0.52
RCR	6.6	0.59

Table 5.15: The Effect of the Cost of Land and Water on Efficiency in Zone 3

Description	Maize		Wheat		Potatoes		Sunflower		Cotton
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr	Irr
RCR (section 5.4)	2.33	1.15	1.93	1.06	0.47	0.27	1.92	1.05	0.95
RCR	1.65	1.91	1.34	1.66	0.36	0.34	1.34	0.83	2.15

Table 5.16: The Effect of the Cost of Land and Water on Efficiency in Zone 4

Description	Maize Irrigation	Cotton Irrigation	Wheat Irrigation
RCR (from section 5.4)	2.07	0.89	1.19
RCR	2.07	0.83	1.28

The RCRs for the different zones change marginally if the input costs are adjusted with the economic exchange rate. The difference in the magnitude by which the RCRs increase can be attributed to the fact that there are differences in input use between regions, and that different inputs are not affected in the same way by changes in the exchange rate. The larger the change in the RCR in a specific region, the more sensitive that region is to changes in the exchange rate. Interesting to note is that the more extensive the region, the more sensitive the RCR is for changes in the exchange rate.

(2) Sheep

Table 5.13 shows the RCRs for sheep production in different regions. Semi-extensive sheep farming in Zone 3 has a comparative advantage over the other regions. If only extensive sheep farming is compared Zone 1, it has a comparative advantage over the other regions.

As was the case for beef, the RCRs change when the input costs are adjusted with the economic exchange rate. These changes are, however, only marginal.

Table 5.17: The Effect of the Cost of Land and Water on Efficiency in Zone 5

Description	Maize		Wheat		Sorghum		Soyabeans		Cotton	
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr
RCR (from section 5.4)	2.97	2.20	3.42	0.84	1.41	1.24	3.42	1.21	1.64	1.23
RCR	2.15	2.72	2.32	1.15	0.78	1.47	2.36	1.27	1.24	1.69

Table 5.18: The Effect of the Cost of Land and Water on Efficiency in Zone 6

Description	Maize		Wheat		Potatoes	Tobacco	Sunflower	Sorghum	Soyabeans	
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Irr
RCR (section 5.4)	2,13	0,83	1,31	1,31	0,78	0,54	1,29	1,26	1,68	1,84
RCR	1,70	1,05	1,18	1,37	0,69	0,72	1,02	0,98	1,39	2,99

5.5 THE EFFECT OF LAND AND WATER PRICES ON EFFICIENCY RATIOS

Until now, the net returns to land and water served as proxy for comparative advantage. The reason for this is that land and water are two of the scarcest resources in South Africa, and the aim is to maximize returns to these two resources. It is, however, also necessary to determine the effect of land and water on returns to management since production decisions lie with management. This implies that management will also consider the cost of land and water when making production decisions. In this section, comparative advantage with management as proxy for comparative advantage was calculated. It is, however, important to note that management is assumed to be the same across all zones.

This section presents the results on the effect of the cost of land and water on efficiency levels in different zones. Results of the CEA analysis are shown in Tables 5.14 to 5.18. Since the effect of changes in the exchange rate on input cost was calculated above, this section incorporates those changes from the start. Maize was, furthermore, regarded as an import substitute in this section.

In all the zones dryland production has become more competitive in relation to irrigation, mainly because of the cost of water (compare rows 1 and 2). For example, dryland maize production now has a comparative advantage over irrigated maize in Zone 3. In Zone 1 wheat production (dryland) still does not have a comparative advantage over potato production (irrigation), but the gap between the RCR's have decreased considerably. The amount of water used per crop will also influence its comparative advantage status. In Zone 3 sunflower (irrigation) now has a comparative advantage, whereas cotton (irrigation) previously had a comparative advantage over other crops produced in Zone 3. In some instances dryland production now has a comparative advantage over irrigation production. This is the case in Zones 5 and 6, where sorghum (dryland) now has a comparative advantage in contrast with irrigation production that had a comparative advantage.

The results in Table 5.15 show that the intensity of water use causes one crop to lose its comparative advantage to another crop (cotton irrigation to sunflower irrigation). The increase in the price of irrigation land caused all the irrigated crops to be less competitive than in the original scenario. The effect of changes in water cost is also evident from Table 5.15.

Since all the crops in Zone 4 are irrigated, no comparison can be made with regard to dryland production practices. It is, however, clear that changes in land and water prices will influence the efficiency of production in Zone 4 (Table 5.16).

Tables 5.17 and 5.18 show that, due to an increase in the cost of production of irrigated crops, dryland production of sorghum took over the comparative advantage. In Zone 5, sorghum production is now more efficient than wheat production (irrigation) and in Zone 6, sorghum production is more efficient than maize production (irrigation). The additional capital investment on irrigation land furthermore strengthens dryland production comparative advantage relative to that of irrigated land.

In summary, the above analyses show the following general results:

- Water cost will influence the competitiveness of dryland production in relation to irrigation production;
- The amount of water used will in future influence the competitiveness of production;
- Dryland production practices may in some instances be more advantageous than irrigation production practices; and
- The intensity of water use may cause one crop to lose its comparative advantage to another crop.

5.6 CONCLUSIONS

5.6.1 General

Different factors contributed to market distortions within South African agriculture. These distortions caused scarce resources to be used sub-optimally. Although it is not the aim of this study to quantify the welfare effect of the non-optimal use of scarce resources, it can be concluded that the non-optimal use of resources had a negative effect on the welfare of farmers. This is clearly illustrated by the larger economic returns than private returns in Table 5.4. While the NPE and EPR results in Table 5.5 indicate the existence of market distortions in the market for the products investigated.

Three main factors contributed to the market distortions observed in this chapter, namely:

- distortions in product prices, mainly due to the statutory powers of the different Marketing Boards;
- the exchange rate; and
- tariffs and subsidies levied on inputs.

The first two of these contributed the most to distortions in the market, whilst the latter's contribution amounted to less than 15 percent. This has important implications for policy makers. Clearly, the implementation of the new Marketing Act (Act 47 of 1996) is a step in the right direction. Under this act all the statutory Marketing Boards are to be abolished during 1997. Taking into account the results in this chapter, the welfare of farmers will increase as private and economic prices of commodities move closer to each other. In other words, as farmers use their scare resources more efficiently, returns to their investments will increase. If the linkages of agriculture with the rest of the economy are taken into account, the welfare of the whole population will increase.

For this, however, to take place, structural adjustment of the agricultural economy will have to take place. Signs of structural adjustments are already visible since the deregulation process started in different industries. For example, Jooste (1996) has shown that since abolishment of the compulsory auction markets and controlled marketing of red meat slaughter, distribution patterns of beef started to change. The structural adjustment process should, however, not be isolated at farming level, but must expand throughout the agricultural economy, i.e. structural adjustment must also take place on the input and output sides. The high level of concentration on the output side in different industries, such as the red meat and grains industries, is an impediment within an open economy.

For farmers to utilize their scarce resources more optimally, they must be guided by comparative advantages that exist between regions. This is especially important in the light of the liberalization process that is taking place in the world market for agricultural products. South African producers will have to compete on the global market in order to ensure their sustainability in future.

The DRC methodology was used in this study to determine the comparative advantages of different products in different zones. The comparative advantages need to be exploited by farmers and the right incentives need to be given by government to farmers to pursue this advantage. The comparative advantages calculated are based on the returns to land and water. This essentially means that policies such as the new Water Act will have a definite impact on the usage of water. This will indirectly influence the utilization of other scarce resources. Government policies must be evaluated against this background, i.e. the effect of such policies must be measured against the effect that it will have on the utilization of scarce resources. In Zones 1, 3, 4, 5 and 6, crops under irrigation have comparative advantages over other crops cultivated in those zones. Increasing the cost of water may have an influence on the comparative advantage a crop may hold.

It is also important to take into account the climate, biological and physical constraint in each zone when evaluating comparative advantages for different zones. A crop may have a comparative advantage over other crops, but due to climate, biological and physical constraints can not be produced throughout that zone. In this instants the second best option must be identified.

The distance from markets must also be considered. Transport cost plays an increasingly important role in the competitiveness of agricultural producers. Producers may have comparative advantage in producing a product in a specific region, but due to transport costs it may not be profitable to produce that crop. . It is a well known fact that South Africa has superior infrastructure over other sub-Saharan Africa countries, but it is still more expensive to transport a ton of wheat from the Western Cape to Gauteng than it is to transport a ton of wheat from the United States to Gauteng. This means that sectors other than the agricultural sector may cause resources in agriculture not to be used efficiently. Policy makers need to consider this when revising or implementing policies.

Due the newly found position in the world market for agricultural products and the deregulation process currently underway in South Africa, world prices of agricultural products will have a large influence on prices received by domestic producers. Exchange rate policies are very important policy measures used by governments to influence their economies. This is clearly also the case in South Africa.

5.6.2 Land and Water

Policies regarding land and water will have a major influence on the comparative advantage South Africa may hold over the production of agricultural products in other countries. These policies should be considered against this background. Not only will policies on land and water influence comparative advantage between countries, but also between regions in South Africa. One should expect changes in resource use if water tariffs in South Africa are inclusive of its scarcity value. The change in production patterns that can be expected if the latter is implemented will differ between regions. It may be relatively easy to substitute seasonal crops with each other, but this will not be the case with long-term crops, such as sub-tropical fruits and citrus.

When implementing water tariffs inclusive of its scarcity value, one should also consider the capital investment made in irrigation agriculture together with the greater price risk due to liberalization and deregulation. These policies should therefore be evaluated in the broader framework of the internationalization of agriculture, taking into account domestic resource endowments. If policies regarding water and land do not take these factors into account, it may be detrimental to the economy as a whole, i.e. the effect on the balance of payments and Gross Domestic Product must be accounted for. Policy makers must take into account the forward and backward linkages of agriculture with the rest of the economy as well as the agriculture employment multiplier.

5.6.3 Other Issues

Other factors that should be considered are the demand and supply forces domestically and internationally. Although a crop may hold a comparative advantage over other crops, unlimited production will cause prices to drop and thus erode its comparative advantage. The balance between supply and demand and the association with comparative advantage is not clear. The development of a general equilibrium model that incorporate resource endowments and supply and demand forces is necessary to get a more clear understanding of these forces. Such a model will give policy makers the tools to base policies on.

6. Sensitivity Analysis

6.1 INTRODUCTION

The deregulation process in the domestic agricultural market and the opening up of the international trade arena due to world trade liberalisation under the auspices of the World Trade Organization (WTO) will bring about changes in the agricultural economic structure of South Africa. One will expect production patterns to become more efficient in order to increase competitiveness. This can, however, only be achieved if producers adhere to comparative advantage principles. Freer trade with the rest of the world entails that domestic commodity prices will be derived from the international prices of these agricultural commodities. This will influence the economic efficiency of different production systems in South Africa.

In Chapter 5, the exchange rate was identified as a major factor explaining the difference between private and economic costs and benefits. Input costs only contributed marginally to distortions in the market. The effects of changes in the exchange rate on input costs were subsequently tested. Since the effect of the exchange rate on input costs only take place over time as few inputs are directly imported, producers have time to adjust to changes in input costs, resulting in a small effect over time. The assumption underlying this is that producers do plan and adjust their production according to changes in input costs.

The economic efficiency of one crop relative to another will also be influenced by relative changes in output prices. As was mentioned, output prices will, in the future, be a function of international prices, which is expected to increase due to world trade liberalization. The RCRs were recalculated for different levels of international prices or relative commodity prices to that commodity which has a comparative advantage in a specific zone. The sensitivity of RCRs to changing yields was also calculated. The economic efficiency of a crop relative to another was calculated by changing the economic price and yield of that crop with all other factors at constant levels.

6.2 SENSITIVITY ANALYSIS FOR FIELD CROPS

6.2.1 Economic Efficiency of Field Crops with Respect to Changes in Price

Table 6.1 shows the threshold price and percentage change in the economic price for different crops in different regions at current yield levels to become efficient. The results include a depreciation of 10 percent in the Rand/Dollar exchange rate.[2]

In Zone 3, the import price of sunflower (irrigated) has to be higher than $281.93 per ton (at current yields) to become efficient. This represents a 21 percent increase in the import price. The import price of crops produced under dry land conditions, other than cotton, must be more than double to become efficient in Zone 3. In Zone 4, the import price of maize (irrigation) will have to increase by 78 percent or to $185 per ton at current yield levels to become efficient. The same applies to maize produced under dryland conditions in Zone 5.

Maize as an export crop was not included in the analysis, due to its large comparative disadvantage to other crops in Table 6.1. It must also be noted that if the depreciation of the Rand is taken into account, another 10 percent must be added to the threshold price. For example, the import price of sunflowers (irrigated) in Zone 3 will have to increase by 31 percent if the

2 The value of he Rand against the US Dollar was decreased by 41 cents, thus from R4.08 per Dollar to R4.49 per Dollar. Theeffect of a depreciation of the Rand willinfluence product prices immediately affecting farmers' returns over the short run. Farmers are, however, due to the nature of farming, not able to respond immediately to such changes.

Table 6.1: Change Needed in Price to Reach the Economic Efficiency Range

Item	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Percentage change in price needed to reach the efficiency range						
Maize - dryland*			^^		78%	
Maize - irrigation*			20%	78%	42%	XXX
Wheat - dryland			^^			48%
Wheat - irrigation			10%	22%	XXX	18%
Sunflower - dryland			^^			46%
Sunflower - irrigation			21%			
Sorghum - dryland					38%	
Sorghum - irrigation					16%	40%
Soybeans - dryland					^^	55%
Soybeans - irrigation					14%	40%
Cotton - dryland			XXX	XXX	50%	
Cotton - irrigation					12%	
Threshold price ($/ton)						
Maize - dryland*			^^		185.12	
Maize - irrigation*			124.8	185	147.68	XXX
Wheat - dryland			^^			232.36
Wheat - irrigation			172.7	191.54		185.26
Sunflower - dryland			^^			340.18
Sunflower - irrigation			281.93			
Sorghum - dryland					144.90	
Sorghum - irrigation					121.80	147
Soybeans - dryland					^^	353.4
Soybeans - irrigation					259.92	319.2
Cotton - dryland			XXX		2.66 c/kg	
Cotton - irrigation				XXX	2.02 c/kg	

Notes: * maize regarded as import substitute
^^ more than double
XXX crop with the comparative advantage (as calculated in Chapter 5)

depreciation of the Rand is not accounted for. It is therefore clear that the exchange rate plays a major role in determining the efficiency range of products in South Africa.

6.2.2. The Threshold Yield for Production Efficiency

In Table 6.2, threshold yields for different products in different zones are presented. The threshold yield was calculated by keeping the economic price constant to determine the change in yield required for a crop to become efficient.

The results from the sensitivity analysis in Table 6.2 show that to be able to compete with dryland cotton at the economic price calculated in Chapter 5, irrigated maize yields in Zone 3 need to rise from current levels by 15 percent; irrigated wheat by seven percent; sunflower (dryland) by 90 percent; and irrigated sunflower by 14 percent. The yield of maize and wheat that is irrigated in Zone 4 has to increase by 65 percent and 17 percent, respectively, to become efficient.

In South Africa, it is unrealistic to expect an increase of 75 percent in yield to 8.75 tons per hectare for dryland maize as shown in Table 6.2 for Zone 5. The increases shown in Table 6.2 must therefore be interpreted carefully. It must furthermore be remembered that the 10 percent depreciation of the Rand is also reflected in the threshold yields in Table 6.2. If the Rand does not depreciate with 10 percent, as was

Table 6.2: Threshold Yield of Different Crops in South Africa to Become Efficient

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Percentage change in yield per hectare needed to reach the efficiency range						
Maize - dryland*			^^		75	
Maize - irrigation*			15%	65%	41%	XXX
Wheat - dryland			^^			37%
Wheat - irrigation			7%	17%	XXX	14%
Sunflower - dryland			90%			30%
Sunflower - irrigation			14%			
Sorghum - dryland					30%	
Sorghum - irrigation					12%	30%
Soybeans - dryland					^^	40%
Soybeans - irrigation					12%	32%
Cotton - dryland			XXX		45%	
Cotton - irrigation				XXX	9%	
Threshold yield (t/ha)						
Maize - dryland*			^^		8.75	
Maize - irrigation*			8.63	9.9	11.28	XXX
Wheat - dryland			^^			2.46
Wheat - irrigation			5.83	5.85	XXX	5.13
Sunflower - dryland			1.9			1.56
Sunflower - irrigation			2.28			
Sorghum - dryland					6.50	
Sorghum - irrigation					8.96	3.90
Soybeans - dryland					^^	2.37
Soybeans - irrigation					3.92	3.17
Cotton - dryland					2,175kg/ha	
Cotton - irrigation				XXX	3,270kg/ha	

Notes: * maize regarded as import substitute
^^ more than double
XXX crop with the comparative advantage (as calculated in Chapter 5)

the case in this particular analysis, the required threshold yields would have been higher.

6.2.3 The Effect of Land and Water Prices on Efficiency Ratios

In Sections 6.2.1 and 6.2.2, the net returns to land and water served as proxy for comparative advantage. In this section comparative advantage with management as proxy for comparative advantage was calculated. It is, again, important to note that management is assumed to be the same across all zones (similar to Section 5.5).

This section presents the results on the effect of the cost of land and water on efficiency levels in different zones. The results of the sensitivity analysis with regard to land and water are shown in Rows 2 to 4 in Tables 6.3 to 6.7:

- Although irrigated land is more productive than dryland, the premium paid for the use of irrigated land will influence its comparative advantage over dryland. In order to test the sensitivity of the RCRs to changes in the price of irrigated land, rental values for irrigated land was increased by a factor of 10 percent. This factor also reflects the extra capital investment that is made on irrigated land, such as irrigation equipment and canals.
- Since the shadow price of water may vary across zones, it was adjusted by 10 percent (both

Table 6.3: The Effect of the Cost of Land and Water on Efficiency in Zone 1

Description	Wheat Dryland	Potatoes Irrigation
RCR (Section 5.5)	6.60	0.59
RCR: Increase in land price	5.45	0.67
RCR: Increase in water price	5.37	0.68
RCR: Decrease in water price	5.53	0.66

Table 6.4: The Effect of the Cost of Land and Water on Efficiency in Zone 3

Description	Maize		Wheat		Potatoes		Sunflower		Cotton
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr	Irr
RCR (section 5.5)	1.65	1.91	1.34	1.66	0.36	0.34	1.34	0.83	2.15
RCR: Increase in land price	1.40	1.91	1.12	1.66	0.33	0.34	1.13	0.93	2.15
RCR: Increase in water price	1.61	1.99	1.31	1.72	0.36	0.35	1.31	0.84	2.27
RCR: Decrease in water price	1.69	1.83	1.38	1.59	0.37	0.33	1.38	0.81	2.03

Table 6.5: The Effect of the Cost of Land and Water on Efficiency in Zone 4

Description	Maize Irrigation	Cotton Irrigation	Wheat Irrigation
RCR (section 5.5)	2.07	0.83	1.28
RCR: Increase in land price	2.07	0.83	1.28
RCR: Increase in water price	2.07	0.84	1.29
RCR:Decrease in water price	2.07	0.82	1.27

Table 6.6: The Effect of the Cost of Land and Water on Efficiency in Zone 5

Description	Maize		Wheat		Sorghum		Soybeans		Cotton	
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr
RCR (section 5.5)	2.15	2.72	2.32	1.15	0.78	1.47	2.36	1.27	1.24	1.69
RCR: Increase in land price	2.15	3.28	2.32	1.42	0.78	1.80	2.36	1.63	1.24	1.94
RCR: Increase in water price	2.15	2.82	2.32	1.19	0.78	1.52	2.36	1.31	1.24	1.76
RCR: Decrease in water price	2.15	2.62	2.32	1.11	0.78	1.42	2.36	1.24	1.24	1.63

Table 6.7: The Effect of the Cost of Land and Water on Efficiency in Zone 6

Description	Maize		Wheat		Pota-toes	Tobac-co	Sun-flower	Sorg-hum	Soybeans	
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Irr
RCR (sedtion 5.5)	1.70	1.05	1.18	1.37	0.69	0.72	1.02	0.98	1.39	2.99
RCR: Increase in land price	1.70	1.20	1.18	1.55	0.69	0.76	1.02	0.98	1.39	3.28
RCR: Increase in water price	1.70	1.07	1.18	1.39	0.69	0.74	1.02	0.98	1.39	3.12
RCR: Increase in water price	1.70	1.03	1.18	1.34	0.69	0.70	1.02	0.98	1.39	2.85

upwards and downwards) to reflect the sensitivity of the RCRs to changes in the price of water.

6.2.4 Conclusion

The sensitivity analysis for field crops, without accounting for water and land prices and policies, in different zones have shown that:

- exchange rate policies will influence the comparative advantage of field crops in South Africa; and
- crops that are irrigated become efficient faster than crops produced under dryland conditions.

The effect of exchange rate policies should be carefully considered since it will influence the competitiveness of the South African agriculture and the contribution of agriculture to the GDP. Due to economic factors mentioned in Chapter 3, one would expect the exchange rate to depreciate further in the future. The rate of such depreciation will depend largely on foreign investment in South Africa. Intervention by the Reserve Bank of South Africa to support the value of the Rand, could influence agriculture negatively. One must also consider the other side of the coin, namely what affect a further depreciation in the exchange rate will have on the rest of the economy. The

Table 6.8: Efficiency Ranges for Beef in Different Zones

Zone 1 Com	Zone 2	Zone 3 Com	Zone 3 Small scale	Zone4 Com	Zone4 Small scale	Zone 5 Com	Zone 5 Small scale	Zone 6 Com
Percentage change in price (R/kg)								
6-7%		XXX	60%	^^	^^	6%	46-47%	^^
Increase necessary in the number of cattle								
6		XXX	335	1,040	1,095	20	52	771
Ha per LSU								
6.44		XXX	4.41	3.51	3.38	3.13	2.55	1.96
(7)			(7)	(13)	(13)	(3.64)	(3.64)	(7)

Notes: ^^ More than double
XXX Zone with the comparative advantage (as calculated in Chapter 5)

Table 6.9: Efficiency Ranges for Sheep in Different Zones

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Percentage change in price (R/kg)					
XXX	^^	85%	^^	^^	60%
Increase necessary in the number of sheep					
XXX	>5000	1,645	2,071	3,780	1,114
Ha per SSU					
XXX	0.41	0.43	0.43	0.56	0.43
	(2.23)	(1.02)	(0.99)	(2.22)	(0.76)

Notes: ^^ more than double
XXX zone with the comparative advantage (as calculated in Chapter 5)

determination of such affects does, however, fall beyond the scope of this study.

6.3 SENSITIVITY ANALYSIS FOR LIVESTOCK PRODUCTS

6.3.1 Sensitivity Analysis for Beef

The results of the sensitivity analysis for beef are shown in Table 6.8. The efficiency ranges of beef production systems in Zones 1, 4, 5 and 6 were calculated relative to Zone 3.

The price of beef in Zones 1 and 5 has to rise by only 6 to 7 percent to become efficient at current off-take rates. It shows that beef in Zone 3 only has a narrow margin of economic efficiency and dominance over beef being produced in Zones 1 and 5.

Farmers can also increase the number of cattle on their farms to increase efficiency if all other factors remain constant, that is area used, price and off-take rate. In Zone 1, farmers only have to increase cattle numbers by six per farm to become efficient. This is in stark contrast to commercial farmers in Zone 4, which require an additional 1,040 cattle per farm to become competitive. In reality, however, the increase in the number of cattle is a function of the carrying capacity of the land. An increase in the number of cattle per hectare without supplying extra food will lead to natural resource degradation that is not sustainable. Table 6.3 furthermore shows that if farmers in, for example, Zone 6 can become efficient by reducing the number of hectares per livestock unit to approximately two from seven, thus enabling them to increase the number of cattle on the original area.

Due to the RCR's linear and static nature, the competitiveness of beef among regions is not shown. This entails that the narrow margin of economic efficiency between Zones 1 and 3 must be evaluated within a trade context, since the transport differential between Zone 1 and Zone 3 relative to South Africa's largest consumer market (Gauteng Province) will increase the economic efficiency margin.

6.3.2 Sensitivity Analysis for Sheep

Table 6.9 shows the efficiency ranges for sheep (extensive) in different regions. The price of sheep has to rise with 85 percent and 60 percent, respectively, in Zones 3 and 6 to become efficient at current off-take rates. In all the other zones, the price will have to double in order to become efficient in relation to Zone 1.

The dominance of Zone 1 over other zones is further demonstrated by the increase in the number of sheep needed if all other factors remain constant. This is, however, seldom achieved since carrying capacity of land is fixed. The third column in Table 6.9 shows the reduction in the number of hectares per small stock unit needed to facilitate the increase in sheep numbers up to the efficiency range.

7. Summary and Conclusions

7.1 INTRODUCTION

South Africa is one of seven countries in the Southern African Development Community (SADC) participating in the Research Program on Regional Agricultural Trade and Changing Comparative Advantage in Southern Africa. Comparative economic advantage (CEA) analysis is the first step in generating information and analysis that will inform and guide policy design in the region to exploit CEA and allocate resources to their most productive uses.

In order to keep the study manageable, and following the suggestions of the Steering Committee, it was decided to limit the analysis in the following manner. (1) Only certain products/commodities were selected for analysis, namely maize, wheat, potatoes, sunflowers, cotton, sorghum, soybeans, tobacco, beef and mutton. (2) Cultivation practices were limited to irrigation and rain-fed (dryland) production for all the crops, while for beef and maize, large-scale and small-scale production systems were distinguished. (3) Data for the 1994/95 production season were used for all budgets and the subsequent analysis. And (4) South Africa was divided into only a limited number of agro-ecological zones (six in total).

South Africa's agricultural sector consists mainly of commercial farming units. More than 80 percent of all agricultural land is farmed commercially. Data on the commercial farming sector are gathered and processed annually by the National Department of Agriculture located in Pretoria. The data used for different products in this study were mainly derived from these sources. Cross verification of prices, yields, etc., was done by means of information received from the different agricultural Marketing Boards, consultants and regional extension officers. Only limited data on subsistence farming areas available from publications. For this reason, the Departments of Agricultural Economics at the University of Pretoria and the University of Natal engaged in a project aimed at establishing enterprise data for small-scale farming. Macroeconomic data with regard to exchange rates, producer price indexes, international prices and transport cost were obtained from the South African Reserve Bank, various international publications, and private companies. Data used to determine the different agro-ecological zones for South Africa used in this study were obtained from various sources, including maps and GIS information generated by the Departments of Landscape Architecture and also Soil Science at the University of Pretoria.

The final report has the following outline: Chapter 1 provides the introduction to the study. Chapter 2 presents a discussion of the South African agricultural economy and the different commodities to be examined. In Chapter 3, the methodology followed is explained. Different agro-ecological zones are determined in Chapter 4. In Chapter 5, the private and social profitability, as well as domestic resource costs (DRC), of different commodities within different agro-economical zones are evaluated. Chapter 6 comprises a sensitivity analysis. Chapter 7 consists of a summary and conclusions.

7.2 CONCLUSIONS

7.2.1 General

Different factors contributed to market distortions within South African agriculture. These distortions caused scarce resources to be used sub-optimally. Although it is not the aim of this study to quantify the welfare effect of the non-optimal use of scarce resources, it can be concluded that the non-optimal use of resources had a negative effect on the welfare of farmers. This is clearly illustrated by the larger economic than private returns in for many commodities, while the NPE and EPR results indicate the existence

of market distortions in the market for the products investigated.

Three main factors contributed to the market distortions, namely:

- distortions in product prices, mainly due to the statutory powers of the different Marketing Boards;
- the exchange rate; and
- tariffs and subsidies levied on inputs.

The first two of these contributed the most to distortions in the market, whilst the latter's contribution amounted to less than 15 percent. This has important implications for policy makers. Clearly, the implementation of the new Marketing Act (Act 47 of 1996) is a step in the right direction. Under this act all the statutory Marketing Boards are to be abolished during 1997. Taking into account the results in this chapter, welfare of farmers will increase as private and economic prices of commodities move closer to each other. In other words, as farmers use their scare resources more efficiently, returns to their investments will increase. If the linkages of agriculture with the rest of the economy are taken into account, the welfare of the whole population will increase.

For this, however, to take place, structural adjustment of the agricultural economy will have to take place. Signs of structural adjustments are already visible since the deregulation process started in different industries. For example, since abolishment of the compulsory auction markets and controlled marketing of red meat slaughter, distribution patterns of beef started to change. The structural adjustment process should, however, not be isolated at farming level, but must expand throughout the agricultural economy, i.e. structural adjustment must also take place on the input and output sides. The high level of concentration on the output side in different industries, such as the red meat and grains industries, is an impediment within an open economy.

For farmers to utilize their scarce resources more optimally, they must be guided by comparative advantages that exist between regions. This is especially important in the light of the liberalization process that is taking place in the world market for agricultural products. South African producers will have to compete on the global market in order to ensure their sustainability in future.

The DRC methodology was used in this study to determine the comparative advantages of different products in different zones. The comparative advantages need to be exploited by farmers and the right incentives need to be given by government to farmers to pursue this. The comparative advantages calculated are based on the returns to land and water. This essentially means that policies such as the new Water Act will have a definite impact on the usage of water. This will indirectly influence the utilization of other scarce resources. Government policies must be evaluated against this background, i.e. the effect of such policies must be measured against the effect that it will have on the utilization of scarce resources. In Zones 1, 3, 4, 5 and 6, crops under irrigation have comparative advantages over other crops cultivated in those zones. Increasing the cost of water may have an influence on the comparative advantage a crop may hold.

It is also important to take into account the climate, biological and physical constraint in each zone when evaluating comparative advantages for different zones. A crop may have a comparative advantage over other crops, but due to climate, biological and physical constraints can not be produced throughout that zone. In this instants the second best option must be identified. The distance from markets must also be considered. Transport cost plays an increasingly important role in the competitiveness of agricultural producers. Producers may have comparative advantage in producing a product in a specific region, but due to transport costs it may not be profitable to produce that crop. It is a well known fact that South Africa has superior infrastructure over many sub-Saharan Africa countries, but it is still more expensive to transport a ton of wheat from the Western Cape to Gauteng than it is to transport a ton of wheat from the United States to Gauteng. This means that sectors other than the agricultural sector may cause resources in agriculture not to be used efficiently. Policy makers need to consider this when revising or implementing policies.

Due the newly found position in the world market for agricultural products and the deregulation process currently underway in South Africa, world prices of agricultural products will have a large influence on prices received by domestic producers. Exchange rate policies are very important policy measures used by governments to influence their economies. This is clearly also the case in South Africa.

7.2.2 Land and Water

Policies regarding land and water will have a major influence on the comparative advantage South Africa may hold over the production of agricultural products in other countries. These policies should be considered against this background. Not only will policies on land and water influence comparative advantage between countries, but also between regions in South Africa. One should expect changes in resource use if water tariffs in South Africa are inclusive of its scarcity value. The change in production patterns that can be expected if the latter is implemented will differ between regions. It may be relatively easy to substitute seasonal crops with each other, but this will not be the case with long-term crops, such as subtropical fruits and citrus.

In summary, the above analyses show the following general results:

- Water cost will influence the competitiveness of dryland production in relation to irrigation production;
- the amount of water used will in the future influence the competitiveness of production;
- dryland production practices may in some instances be more advantageous than irrigation production practices; and
- the intensity of water use may cause one crop to lose its comparative advantage to another crop.

When implementing water tariffs inclusive of its scarcity value, one should also consider the capital investment made in irrigation agriculture together with the greater price risk due to liberalization and deregulation. These policies should therefore be evaluated in the broader framework of the internationalization of agriculture, taking into account domestic resource endowments. If policies regarding water and land do not take these factors into account, it may be detrimental to the economy as a whole, i.e. the effect on the balance of payments and Gross Domestic Product must be accounted for. Policy makers must take into account the forward and backward linkages of agriculture with the rest of the economy as well as the agriculture employment multiplier.

7.2.3 Other Issues

Other factors that should be considered are demand and supply forces domestically and on the internationally. Although a crop may hold a comparative advantage over other crops, unlimited production will cause prices to drop and thus erode its comparative advantage. The balance between supply and demand and the association with comparative advantage is not clear. The development of a general equilibrium model that incorporates resource endowments and supply and demand forces is necessary to get a clearer understanding of these forces. Such a model will give policy makers the tools to base policies on.

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Appendix A

The South African Land Market

A.1 INTRODUCTION

The effects of market distortions are usually capitalized into land values. Market values of land therefore often merely reflect these distortions, rather than the real shadow price of land. The same applies to land rental values (Binswanger and Deininger, 1993). Within this context, it is important to analyze the South African land market more closely.

This appendix is structured as follows: the next section provides an overview of rural land transactions and land transfers in South Africa, as well as a description of land price movements in relation to key economic indicators. Then a model for, and results of, simulating land price changes is described. These results are subsequently used to analyze the gap between market values and productive values of farmland. Thereafter some conclusions are provided.

A.2 THE SOUTH AFRICAN LAND MARKET: HISTORICAL BACKGROUND

Land transactions constitute an important element of the land market. Since 1964, between 7,561 and 14,889 deeds, and between 3.1 million to 5.5 million hectares of rural immovable property, have been transferred annually (Table A.1). The total area of transfers has remained remarkably constant at around 4 percent of the total surface area in the commercial sector.

The average size of land transfers has risen over time. The number of transfers dropped in the 1980s, both nationally and for most size categories, but there does not appear to be a corresponding drop in the total area transferred. Particularly in the upper size ranges of the market for rural land, transfers have remained relatively constant in number, while areas transferred have increased.

Table A.1: Average Annual Rural Land Market Transactions in South Africa, 1964 - 1991

Region	Transfers: total number	Area transferred (ha)	% of land transferred (%)	Average area transferred (ha)
Cape Province	2,942	1,944,641	4.02	661.2
Natal	1,183	254,545	4.28	215.2
Transvaal	5,438	1,112,089	4.19	204.5
Orange Free State	1,358	402,457	4.09	296.4
Total: South Africa	10,921	3,713,732	4.15	328.7

Source: Registrar of Deeds (1992).

Transactions involving smaller parcels of land dominated. Of the 8,852 parcels transferred in 1990/91, 26.8 percent were less than 19 hectares in size, 26.7 percent between 10 to 99 hectares, 17.9 percent between 100 to 299 hectares, 10.4 percent between 300 to 499 hectares, 9.4 percent between 500 to 999 hectares, 5.1 percent between 1,000 to 1,999 hectares, and 3.6 percent above 2,000 hectares. However, the frequency of recorded deed transfers of the smallest parcels is declining in relative terms, which may suggest that progressively more transfers are taking place off the record. Transactions involving larger parcels, on the other hand, dominated the total area transferred. Of the 3.2 million hectares of land transferred in 1990/91, 0.6 percent were parcels less than 19 hectares in size, 3.2 percent between 20 to 99 hectares, 9.2 percent between 100 to 299 hectares, 11.2 percent between 300 to 499 hectares, 18.1 percent between 500 to 999 hectares, 19.5 percent between 1,000 to1,999 hectares, and 38.3 percent above 2,000 hectares.

Figure A.1 shows the relationship between the real land prices and the percentage land transfers in South Africa. It is evident from this figure that real land price is not the only factor influencing land transfers, for instance, a low percentage of land transfers is associated with high land prices in 1977, while a low percentage of land transfers is associated with lower land prices in 1990.

In 1963, total leased land represented only 13.1 percent of total land area; but in 1988 rented, leased and share-cropped land represented 19.5 percent of the total surface area, with considerable regional variation: 26.9 percent in the Orange Free State, 22.9 percent in the Transvaal, 17.3 percent in the Cape, and 15.7 percent in Natal. Hattingh and Herzberg (1980) found that farmers, who already own land, lease land. Moreover, although the official statistics point to a relatively high rental rate of nearly 20 percent of total area, in fact most rentals are between the older and younger generations of the same white family. Such rental arrangements are de facto pension schemes, and the proportions of genuine rentals can be as low as 5 percent. It has been suggested that the low rate of genuine rentals at least partly reflects owners' fear that renters will 'mine' and destroy the fragile land (Van Zyl et al, 1994).

Historic movements of average South African farmland prices since 1955 are subsequently compared to several important variables. First, it is important to see how price movements differed between regions. Figure A.2 shows that, except for the winter rainfall region, price movements over the last decade

Figure A.1: Percentage Land Transfers and Real Land Prices (1964–1991)

Figure A.2.: Real Index of Land Prices in Different Agro-Economice Regions (1960-1991)

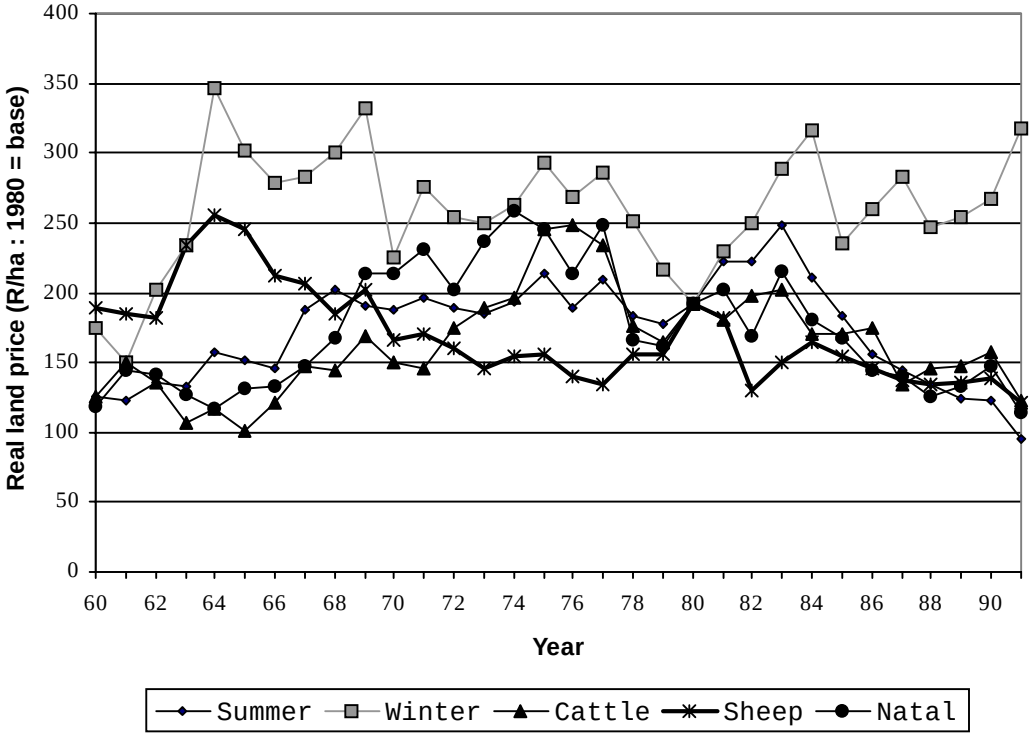


Figure A.3.: Real Land Prices and Returns per Hectare in South Africa (1955-1991)

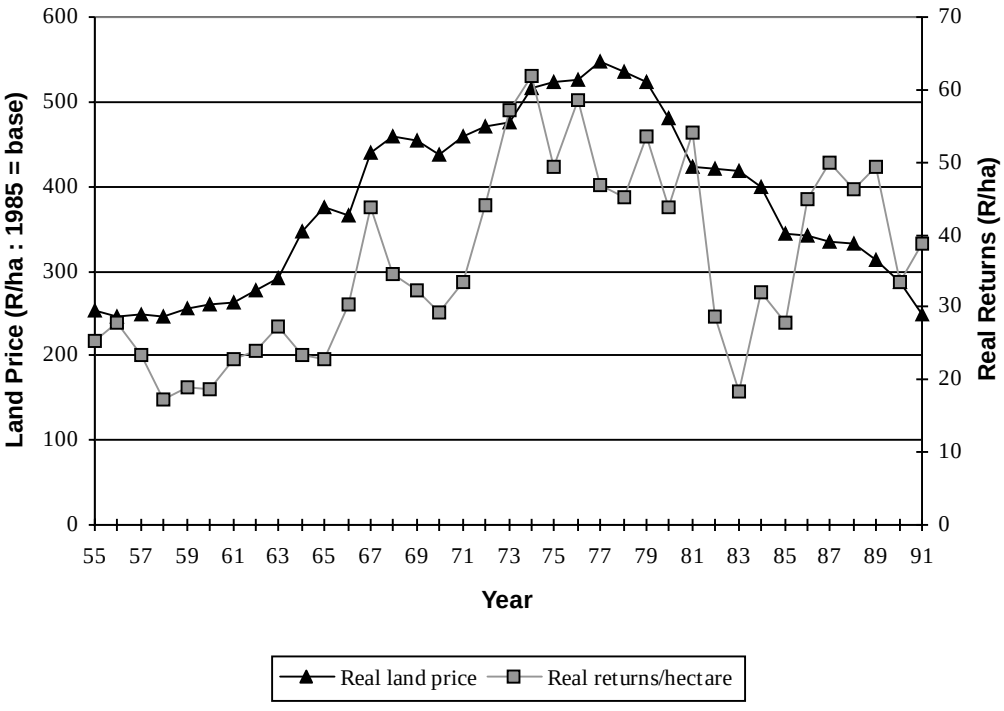


Figure A.4.: Real Land Prices versus Inflation (1955-1991)

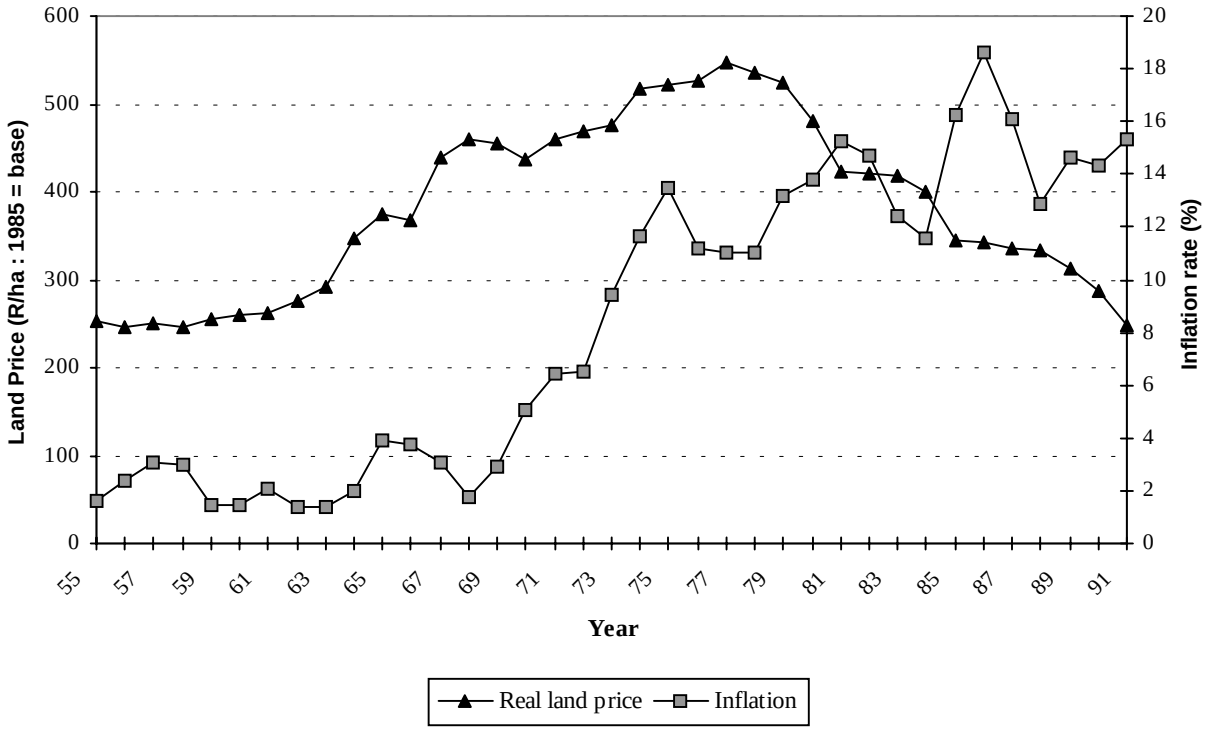
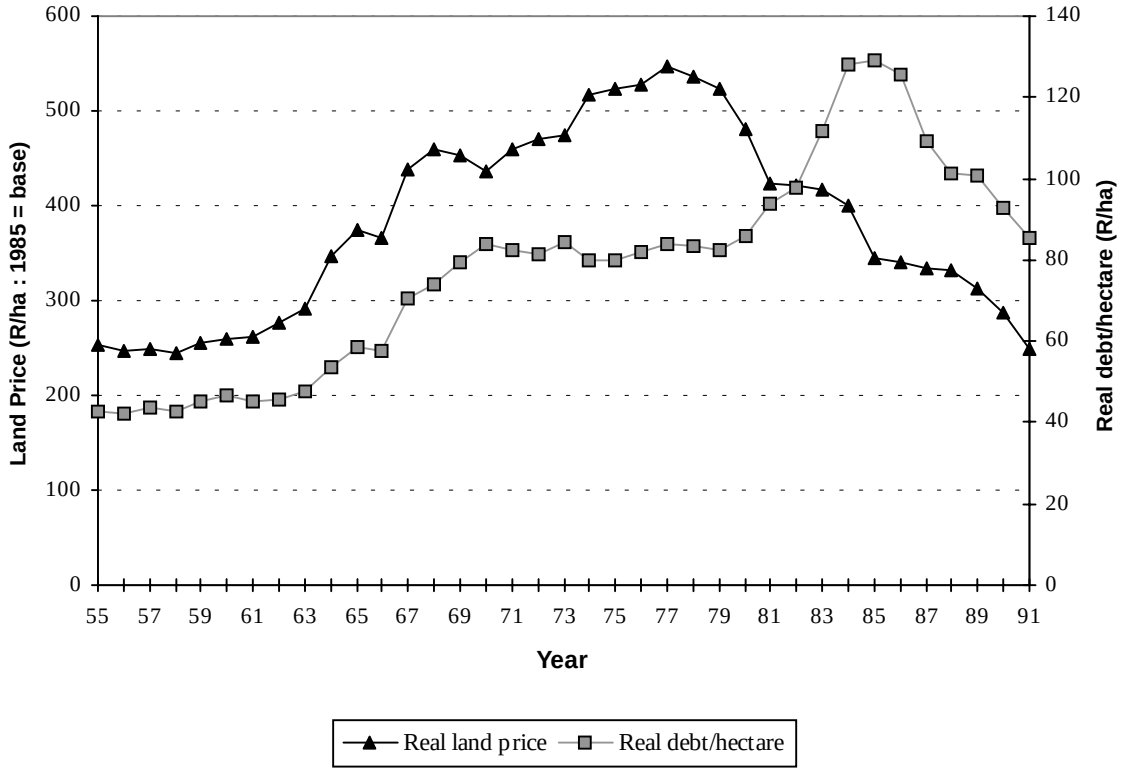


Figure A.5.: Real Estate Debt and Land Prices in South Africa (1955-1991)



were fairly similar for all the regions. Nevertheless, important variations still exist.

Underlying the research on farmland values in South Africa, are some interesting historical patterns of land prices, returns, rents, interest rates, financing and inflation. These patterns are presented in Figures A.3 to A.8 to facilitate evaluation of competing hypotheses suggested by previous research. These patterns provide insight pertinent to model discrimination and are discussed here to provide background for later analysis. The most widely accepted explanation of farmland prices is based on expected returns or rents. Because expected returns are unobservable, an intuitive comparison of real land values with current and lagged real returns is informative.

Recent studies that find returns to be the major explanation of land prices, explain land prices by complicated distributed lags on returns (Alston, 1986; Burt, 1986). In contrast with the United States, as illustrated by Just and Miranowski (1993), Figure A.3 reveals that real land values in South Africa follow an almost parallel pattern to current real returns and that land values appear positively related to recent changes in returns as plausible expectations schemes would require. The major trends in returns and real land prices, however, have been in opposite directions during most of the period since 1983.

Rapid rates of inflation are also used to partially explain land price increases of the late 1960s and early 1970s. Inflation not only reduces the rate of capitalization of future returns, but land serves as a hedge against inflation. Figure A.4 relates real land prices to the inflation rate. Although less volatile than the rate of inflation, land prices follow a similar pattern with a short lag. Thus, the inflation explanation is appealing, even though the mechanism by which inflation affects land values is far from clear.

Explaining land values by access to credit and credit control is supported by a similar pattern, which per hectare farm real estate debt and land prices also follow (Figure A.5). The lag between the 1976 real land price peak and the 1985 debt peak is a direct result of the expectations of agricultural financiers that real farm land prices would increase. The problem,

Figure A.6.: The Debt/Asset Ratio and Land Prices in South Africa (1955-1991)

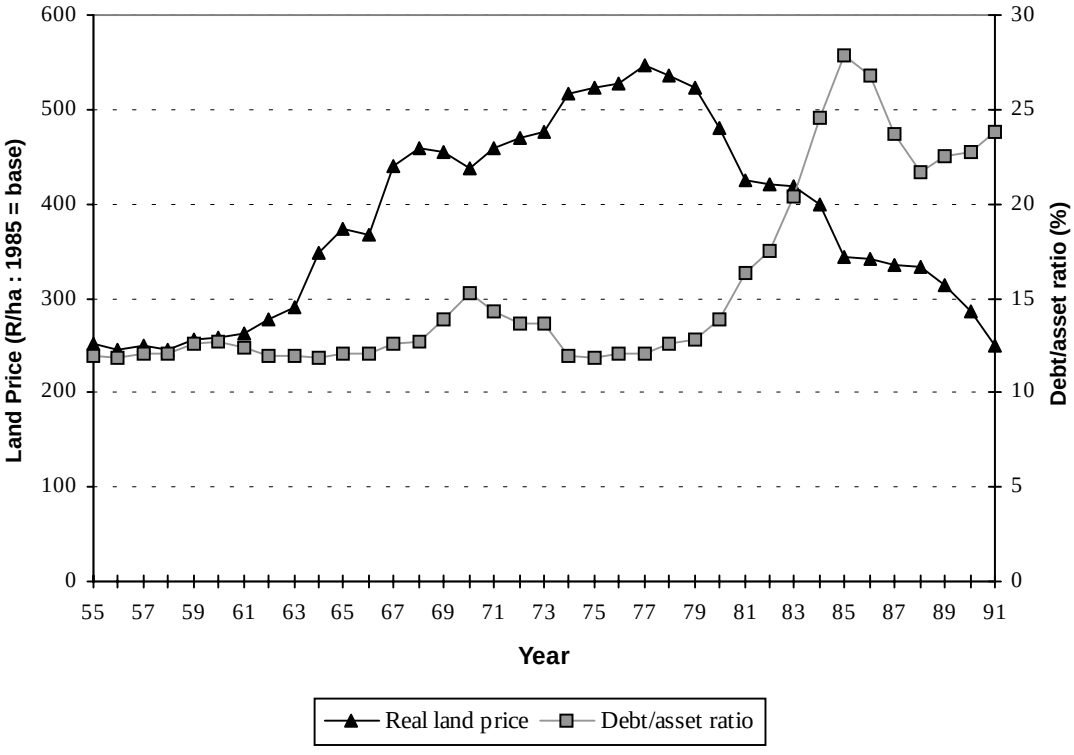


Figure A.7.: Real Land Prices and Solvency in South Africa (1955-1991)

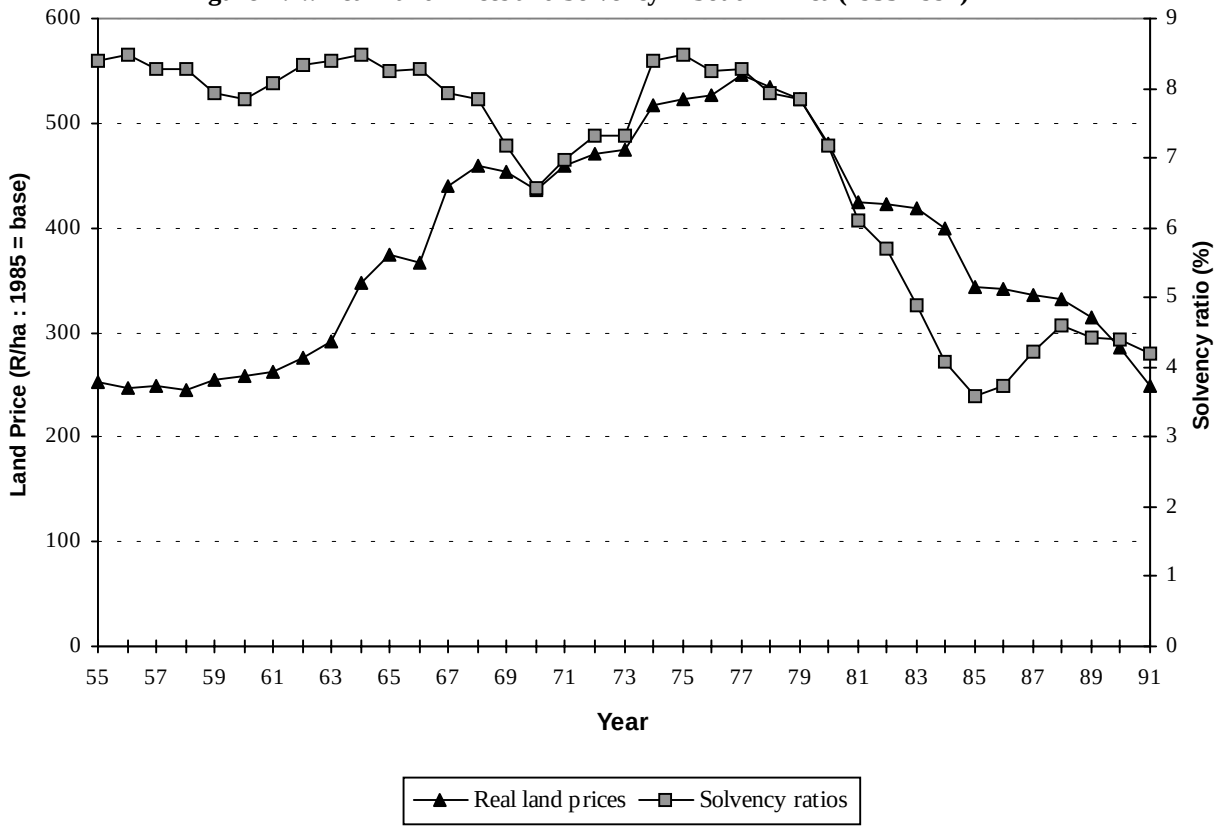


Figure A.8.: Saving and Debt Interest Rates versus Land Prices (1955-1991)

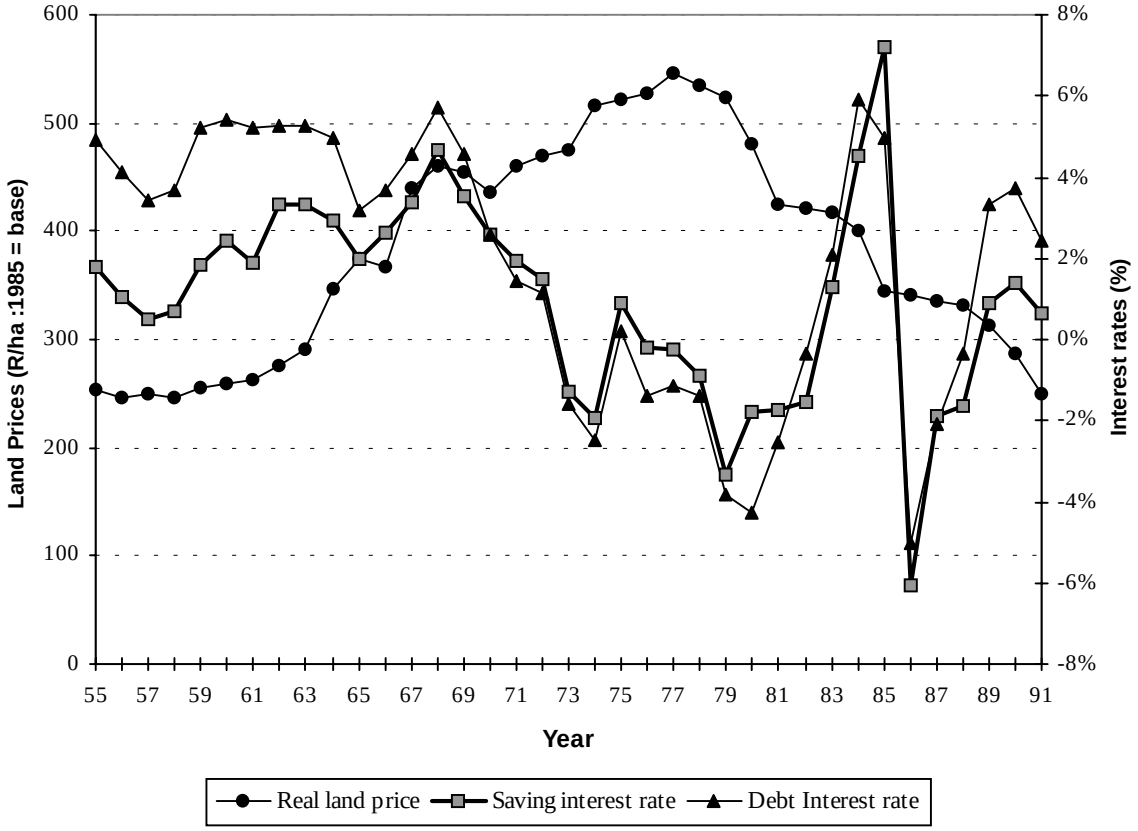


Table A.2: Correlation of Different Variables with the Average South African Land Price

	Inflation rate	Net farm income	Debt load	Interest rate on savings	Interest rate on debt	Debt asset ratio
r	0.4397	0.6209	-0.3188	-0.6548	-0.2433	-0.4770
p-value	0.0678	0.0060	0.1972	0.0032	0.3306	0.0453

however, as shown in Figure A.6, is that farm real estate debt as a percentage of land value remained stable while land prices increased (1955 to 1976) and then increased rapidly when land prices headed into a decline (1979 to 1985). These observations suggest that the farm debt bubble may have occurred more as a consequence of high land values rather than as a causal factor.

Alternatively, the real interest rate on farm real estate debt can be used as an indicator of debt constraints. During the 1970s, low and even negative real interest rates displayed an inverse relationship with land values while high real interest rates in the 1980s were associated with declining land values. Also, the sources of credit changed significantly during the 1970s and 1980s possibly reflecting easier credit. However, traditional sources of credit may have tightened in the 1980s as debt-asset ratios declined, which, in turn, motivated a shift to the Land Bank and agricultural co-operatives for financing. Financing by the Land Bank and agricultural co-operatives went from 29 percent of total financing in 1970 to 47 percent in 1991. Van Schalkwyk and Groenewald (1993) established that there is a negative relationship between the amount of debt financed by agricultural co-operatives and solvency ratios. The increased financing of the Land Bank and agricultural co-operatives therefore leads one to accept that solvency ratios and land prices should have declined. This is illustrated in Figure A.7.

Treating the real interest rate as the opportunity cost of capital, rather than as a measure of credit tightness, the opportunity cost of capital appears to be a more important explanation of land values than credit availability (Figure A.8). That is, the real interest rate can be regarded as an opportunity cost of capital rather than a measure of credit tightness - (the savings interest rate closely parallels the debt interest rate, so empirical distinction is difficult). Because farm real estate debt does not vary sharply in response to changes in the real interest rate on debt, the opportunity cost explanation appears more plausible. The tight credit explanation thus applies to a small component of the land market while the opportunity cost explanation applies to the whole market.

After reviewing the historical data, many of the factors hypothesized to affect farmland values appear to have correlation (Table A.2) that suggest validity and reflect the results obtained by studies examining each individually. These relationships explain why empirical results based on ad hoc and partial analyses are conflicting, and imply that a comprehensive and theoretically defensible framework is needed to identify the relative importance of each.

A.3 MODELING LAND PRICE CHANGES

Modeling the Land Market

The traditional ad hoc econometric approach to empirical analysis has the advantage of tailoring results closely to observed data, but is vulnerable to misleading results due to spurious correlation and an inability to identify proper functional forms. Typically, it can 'identify' only a few factors, so information on interaction with other variables (possibly subject to large changes outside the sample) is not obtained. Alternatively, theoretical analysis has the advantage of maintaining plausible relationships among variables, but suffers from the need for stringent assumptions to obtain unambiguous results (Just and Miranowski, 1993).

This analysis draws on the advantages of both approaches. Economic theory is used to impose plausible

relationships among variables so that econometric identification is possible with more variables. While some restrictive assumptions are required for tractability, the assumptions are arguably as general as unknown implicit restrictions imposed by arbitrary choices of functional forms for ad hoc investigations. Additionally, the resulting model contains several unknown parameters for which good extraneous information exists-parameters that can be identified more accurately from alternative information than econometric estimation. After imposing these coefficients, the remaining parameters are estimated conventionally.

The structural model of land prices used for this analysis includes the multi-dimensional effects of inflation on capital-erosion, savings-return erosion and real debt reduction; it also develops the effect of changes in the opportunity cost of capital. The method of approximation and procedure is largely based on that followed by Just and Miranowski (1993) in their computation of farmland price changes in the United States which was specially adapted by Just (1993) for the South African land market. This model is shown below. It provides a comprehensive framework for analyzing the relative importance of factors determining farmland prices over the past two decades. Free-form econometric investigations cannot estimate coefficients on all variables with sufficient precision to resolve the important issues. The model was estimated for different agro-economic regions and for South Africa as a whole:

$$\overline{p}_t = \frac{\rho(1-\tau_t v_t \psi_g)\overline{P}^* + (1-\tau_t)\overline{R}_t^* - \beta\phi^2\overline{A}\Sigma_t}{f_t\left[1-\tau_t v_t \psi_g + \chi_t(1-\tau_t) + \psi_s Z_t + \psi_t - \psi_d f_t(1-\Delta)Z_t\right]}$$

Where

$$Zt = -(1-\tau_t([\chi_t - r_t - (1+\chi_t)\Delta]/1-\Delta)$$

$$St = (1\text{-}\tau_t v_t \psi_g)^2 p^2 \omega_t + 1\text{-}\tau_t)^2 \sigma_t + 2(1\text{-}\tau_t v_t \psi_g)(1\text{-}\tau_t)\xi_t$$

the variables are

$\overline{p}_t$ = average land price resulting from transactions at the beginning of period t

f_t = 1 plus the current rate of inflation at time t

τ_t = the average tax rate on current income

v_t = the proportion of capital gains taxed in period t

$\overline{P^*}_t$ = average land price expectation for the end of period t held at the beginning of period t

$\overline{R^*}_t$ = average expected net returns to farming per hectare (including subsidies) for period t

$\overline{A_t}$ = average farm size in period t

Σ_t = perceived variance of end-of-year wealth per hectare against beginning-of-year expectations

χ_t = rate of interest earned on savings in period t

r_t = rate of interest paid on debt in period t

Z_t = effective cost of debt

ψ_t = property tax per hectare on real estate in period t

ω_t = perceived variance of end-of-year land price

σ_t = perceived variance of net returns from farming per hectare (including subsidies)

ξ_t = perceived covariance of land price and net returns per hectare

the unknown parameters are:

β = coefficient of absolute risk aversion on profit

ϕ = b*/(b* + b) where b* is the absolute risk aversion coefficient on short-run variations in wealth

ρ = 1 minus the rate of sales commissions on land transactions

Δ = rate of finance charges and other trans actions costs on new debt

and the indicators of strength of various regimes and phenomena are:

ψ_g = proportion of current land value attributable to capital gain

ψ_s = proportion of farmland in farms with a binding minimal savings constraint

ψ_d = proportion of farmland value financed by debt

While the model appears rather complicated, the intuition is straightforward (Just and Miranowski, 1993). First, if all the complications of inflation ($f_t = 1$), taxes ($\tau_t = 0$, $\psi_t = 0$), credit market

Figure A.9 : Actual and Predicted Land Prices in South Africa (1955-1991)

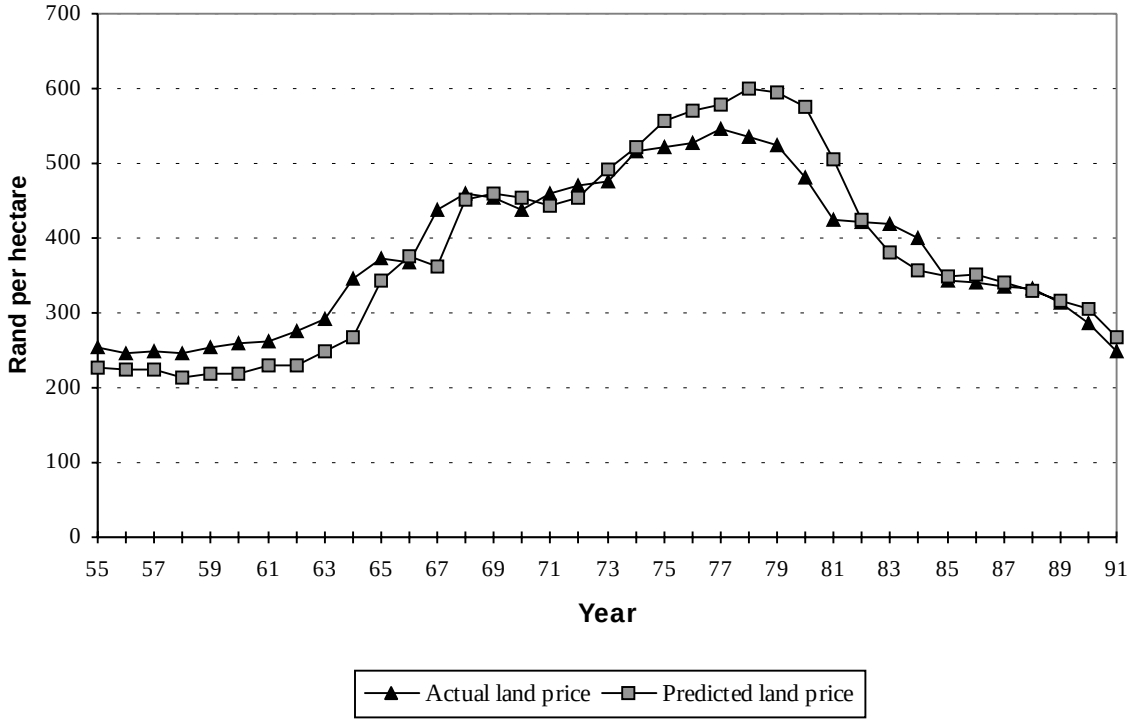
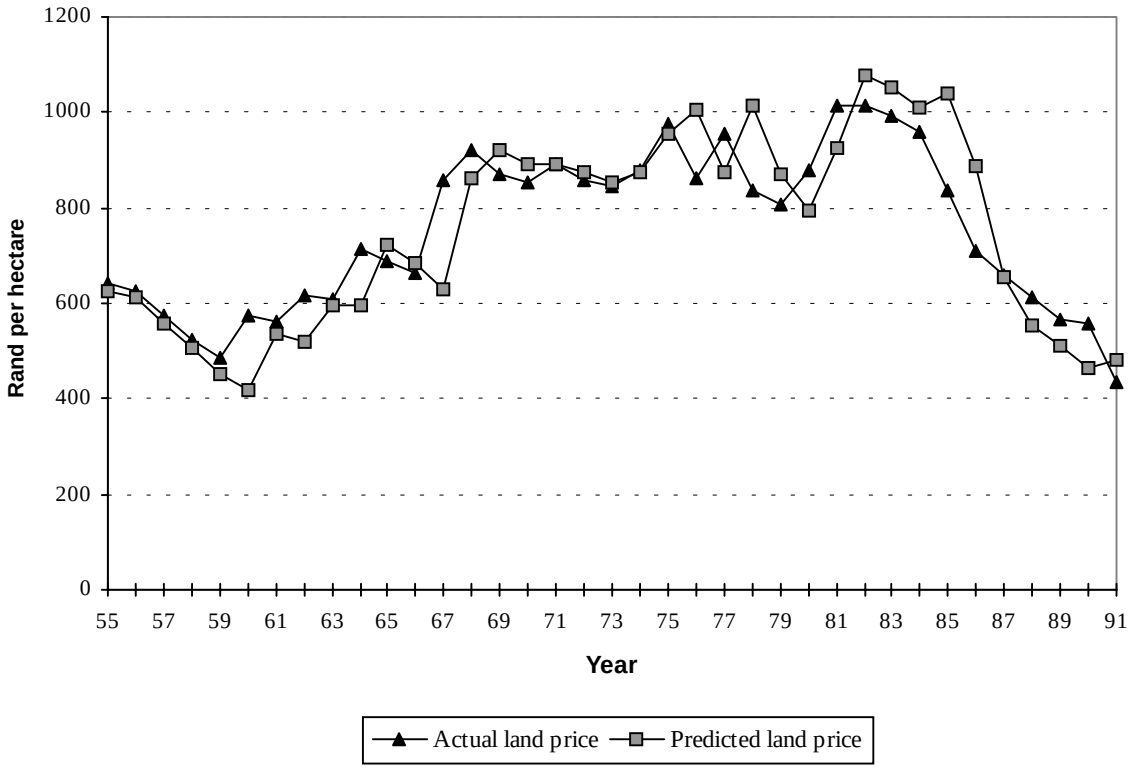


Figure A.10 : Actual and Predicted Prices in the Summer Grain Region (1955-1991)



imperfections ($\chi_t = r_t$), transactions costs ($\Delta = 0$, $\rho = 1$) and risk aversion ($\beta = 0$) are eliminated from the model, then this equation reduces to the standard discounting equation:

$$\bar{p}_t = \frac{\bar{P}^*_t + \bar{R}^*_t}{1 + \chi_t}$$

which in equilibrium ($\bar{p}_t = \bar{P}^*_t$) yields $\bar{p}_t = \bar{R}^*_t / \chi_t$.

Adding simple inflation consideration s multiplies the right hand side of the discounting equation by f_t obtaining $\bar{p}_t = f_t(\bar{P}^*_t + \bar{R}^*_t) / (1 + \chi_t)$ which, in long-run equilibrium, reduces to the same basic equation as does the model developed by Feldstein (1980). All the additional effects in the model are justified as a modification of this equation. To see this, note that the numerator represents the value of holding a hectare of land while the denominator represents the opportunity cost of channeling a Rand's worth of wealth into land. In this context, the terms in the model can be examined and interpreted one by one (see Just and Miranowski, 1993).

Estimating the Model

In this section, the farmland model is estimated for different agro-economic regions and for the country as a whole. The results are used to decompose farmland price changes, beginning with the boom of the 1960s. The results show that inflation and changes in the real returns on capital are major explanatory factors in farmland price swings, in addition to returns to farming. Additionally, the effects of credit market constraints and expectation schemes are considered explicitly in the analytical model. Data for the period 1955 to 1991 were used for estimation. The results are reported for the summer rain region and South Africa. The model was estimated by the non-linear, seemingly unrelated, regression (SUR) method to take advantage

Table A.3: Decomposition of Predicted Real Land Price Changes by Effect for South Africa, 1970 - 1990

Year	Total	Expectations		Risk	Tax Rate Paid	Opportunity Saving	Inflation Debt	
		Price	Returns					
1970	-2.661	-4.425	-0.068	-0.079	-0.034	0.0445	0.207	1.292
1971	2.925	1.573	1.284	-0.385	-0.040	0.338	0.048	0.108
1972	7.650	1.719	1.232	-0.630	0.0020	2.100	0.513	2.715
1973	6.114	1.810	1.650	-0.081	0.096	0.471	0.158	2.009
1974	7.248	12.204	0.252	-0.233	-0.024	-2.162	-0.430	-2.358
1975	2.159	0.259	-1.023	-0.355	0.103	0.867	0.270	2.038
1976	1.719	0.560	1.769	-0.291	-0.113	0.024	-0.038	-0.193
1977	3.931	4.531	-0.967	-0.294	0.085	0.532	0.035	0.009
1978	-1.139	-4.796	-0.072	-0.431	-0.089	1.896	0.439	1.916
1979	-2.831	-3.081	0.705	-0.056	0.085	-1.156	0.085	0.588
1980	-12.513	-10.877	-1.204	-1.211	0.038	-0.055	-0.435	1.232
1981	-16.016	-16.024	1.430	-0.743	0.490	-0.135	-0.599	-0.435
1982	-10.443	-0.185	-4.759	-0.620	-0.400	-1.787	-0.682	-2.011
1983	-5.737	-0.604	-2.422	1.063	0.012	-1.788	-1.253	-0.745
1984	-2.335	-3.693	3.746	0.942	-0.018	-1.378	0.347	-2.281
1985	3.933	-16.058	-0.856	-0.445	0.617	7.445	4.535	8.696
1986	-3.581	-0.820	2.721	0.138	0.096	-2.506	-1.120	-2.090
1987	-2.991	-2.343	-1.150	0.761	-0.256	-0.156	-0.609	0.763
1988	-3.813	0.112	0.957	-0.262	0.110	-1.462	-1.309	-1.959
1989	-4.101	-3.876	0.089	0.306	0.108	-0.316	-0.149	-0.263
1990	-12.733	-11.896	-2.727	0.212	-0.083	0.442	0.505	0.813

of the high correlation of disturbances that exists among regions. Predictions fit the 1955 to 1990 data very closely (see Figures A.9 and A2.10 for South Africa as a whole and the summer grain region, respectively).

Decomposition of Price Movements

To understand the source of land movements, this section decomposed predicted annual land price changes among all of the effects represented in the model. That is, the price changes are decomposed according to the effects represented by the various terms of the numerator and denominator. The decomposition of predicted price changes is reported in Table A.3 for South Africa as a whole by effect for the years of land price vitality, 1970 to 1990. Note that the inflation effect is on real prices rather than nominal prices (the inflation effect on the numeraire is removed). The predicted price change and its components are reported in real 1985 Rands.

Land price expectations are the most important explanatory force in every agro-economic region. However, the change in land price expectations is explained by changes in previous prices and, thus, indirectly by previous changes in other variables. With extrapolative expectations, the change in price expectations for period t is explained by the change in price expectations and all other variables in period t-1, the change in price expectations in t-1 by price expectations and all other variables in period t-2, etc. Thus, the relative role of variables other than price expectations is crucial in understanding the wide swings in the South African land prices. The contribution of price expectations in each year is primarily important in understanding the dynamic effects of the other variables.

For the remaining variables, the most striking effect is the dynamic role of inflation and the opportunity cost of capital. These two effects are each roughly as important as increased returns to farming. This is well illustrated in Table 12.3 for the South African 1971 land price take-off period and the 1975 surge. From 1971 to 1973, the inflation rate increased from 6.4 percent to 9.4 percent (as measured by the consumer price index). This increase in the rate of inflation explains 35 percent of the predicted land price increase in 1972 in South Africa. This effect is the direct result of capital erosion, i.e. the opportunity cost of a Rand invested in any activity declined because it would be worth 9.4 percent (rather than 6.4 percent) less in real terms after one year of use (apart from the rate of return it earns).

Another major force in the 1971 take-off period is the opportunity rate of returns on capital. From 1968 to 1974, the real rate of return on savings dropped from 4,6 percent with 6,5 percent percentage points. This caused investment in land to become more attractive by comparison. This effect explains 27 percent of the predicted land price increase in 1972 for South Africa as a whole. Note that the effect of the rate of interest on debt has a minor effect.

By comparison, the increase in returns to farming explains 16 percent of the predicted change in South African land prices in 1972. Over the five-year period from 1971 to 1975, the rate of inflation and the real rate of return on capital had similar effects to those of farming returns. Following the 1971 take-off period, much of the ensuing land price appreciation was due to the 1968 to 1974 effects working through the system and culminating in price expectations effects. To understand this explanation, note that an initial price increase due to inflation or opportunity cost had a positive effect the following year on price expectations; these higher price expectations, in turn, caused a higher price the following year, which then caused higher price expectations to be transmitted to a third year, and so on. While, on the surface, this explanation may suggest that land price changes are being explained tautologically with land price changes, the adjustment process actually works much like a Nerlovian model. Each external shock has a declining distribution of effects over time, reflected through the land price expectation, which is the lagged land price. Apart from higher expected returns to farming, inflation and opportunity costs are the only major explanatory forces behind the increased price expectations of 1971 to 1977. By 1979, inflation and opportunity cost had returned to pre-1968 extremes. Land prices started to drop in 1977-a direct effect of high inflation. Furthermore, the land price volatility in the 1980s led to large

increases in perceived risk, tending to decrease prices further.

The model predicts the price turn around in 1977 very well. The 1982 shock is primarily due to perceived risk, opportunity-cost and farming returns. From 1973 to 1983, farming returns decreased while the rate of inflation increased. The associated opportunity-cost effect explains about 40 percent of the predicted decline in land prices for South Africa as a whole.

Conclusion

The structural model of land prices includes the multidimensional effect of inflation associated with capital erosion, savings-return erosion and real debt reduction, as well as the effect of changes in the opportunity cost of capital. In spite of the imposition of substantial a priori theoretical structure and extraneous information, the model fits the data well, compared to ad hoc econometric models. The results show that the large price swings are mainly explained by inflation rates and changes in real returns on alternative uses of capital. These effects caused substantial appreciation in 1971 and substantial depreciation in 1978. The large shock of 1971 tended to continue as indirect effects worked their way through land price expectations. The lagged effects of later changes were moderated or offset by changes in other causal variables.

A.4 IS SOUTH AFRICAN AGRICULTURAL LAND OVERVALUED?

In most countries, the major advantage of ownership of land has been the price appreciation of land over time. Unlike most resources used in farming, land does not depreciate or deteriorate if managed properly. Although the farmer has not received the financial benefits of price appreciation in a cash form that is available for direct consumption, appreciation has increased net worth. This increased net worth can be used as a financial base for borrowing funds to expand the farm operation, as well as a cushion or reserve against short-term financial losses that may require refinancing. Thus, land ownership has important income, capital appreciation, and risk-reduction dimensions for the farm operator, as well as the social and family dimensions of a permanent home and residence for the farm family.

The price that must be paid for these attributes of ownership is the substantial capital outlay needed to purchase land. Most farmers, and particularly emerging farmers, do not have sufficient capital for the down payment required for land acquisition as well as enough funds left for machinery, equipment purchases and working capital. The financial requirements of purchasing land can drain valuable funds away from other investment alternatives. The basic question, therefore, becomes one of which method of land acquisition has the highest financial pay-off compared to alternative uses of the farmer's funds, and which alternative is 'financially feasible' or within the financial capability of the farm operator (Boehlje and Eidman, 1984).

The difference or gap between the market and agricultural value of land does not contribute to the farmer's ability to repay a loan made to acquire land. Often, however, this contributes to the ability of the farmer to obtain credit (Binswanger and Deininger, 1993). Van Schalkwyk and Groenewald (1993) found that non-farm factors like policy distortions, policy and institutional expectations get capitalized into market values, hence the difference between the market and agricultural value of land. The non-farm factors, for example, also represent expectations of present landowners that their land can be sold for non-farm purposes. Land in the vicinity of cities is usually more expensive than similar land further afield, not only because of the mentioned expectations but also because of cost savings on transport. They also found that high gross revenues-partially a result of price supports-become capitalized in land values. This tends to lend some support to arguments by Paarlberg (1962) and Groenewald (1978), that the profitability gains the present farming generation receives because of price supports become a cost of doing business for the next generation.

The size of the gap between the agricultural and market value of land is of major importance for land

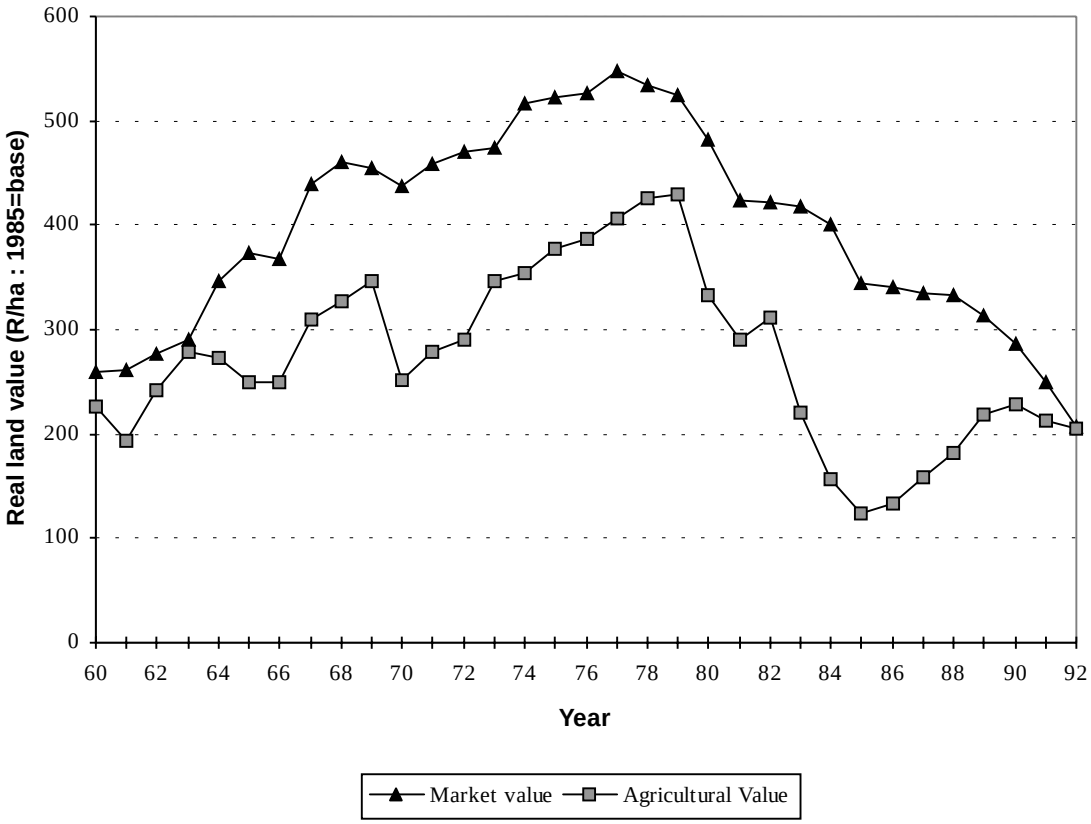
reform purposes, especially if the affordability of a basically market-oriented land reform is taken into account. It is therefore important to understand the forces underlining the difference between the market and land-use value of agricultural land in South Africa. This section aims to identify these forces and to quantify the gap between the market and agricultural value of land.

Alternative Agricultural Value Estimates

According to Boehlje and Eidman (1984), there are generally three methods by which land can be appraised, namely, the market, cost and income approach. The market approach to valuing real estate essentially attempts to determine what the property would bring if sold. The basic philosophy of the cost approach is to inventory the various resources of the farm, estimate their cost, and then sum these costs to obtain a total value. Because of the extremely difficult task of associating a cost with land, this approach is quite difficult to use for unimproved land. In essence, the income approach to valuation determines the long-run profitability of a land investment (Boehlje and Eidman, 1984). The income approach to land valuation was subsequently used because of its consistency with the net present value method of evaluating investments.

The income-capitalization approach is based on the logic that the market value of a piece of land should equal the present value of the stream of all future incomes. In its most simple form (where income is assumed to accrue in perpetuity), earnings value V = I/r, where I is the average yearly return to land and r is the discount or capitalization rate (Locken et al, 1978). This simple formula does not consider income taxes. Both the income stream and the capitalization rate are calculated on a before-tax basis. If taxes are included as a cash expense, then the capitalization rate must also be reduced to an after-tax rate. A number of refinements can be made to this approach to account for changes in the income stream or discount rate, taxes or any other changes that may affect the income

Figure A.11 : Real Market Value and Expected Agricultural Value of South African Land (1960-1992)



generated from a parcel of land over time (Locken, 1976). While these refinements are not difficult to deal with conceptually, empirical implementation requires knowledge of the future income streams and other changes affecting agricultural value. Failure to incorporate these changes by capitalizing current rather than future income streams certainly has an impact on estimates of agricultural values. However, one can argue that agricultural values based on recent performance may be the only acceptable alternative for empirical estimation of the earning value of land. By comparing these agricultural values with those developed through a market approach, one can argue that market participants setting land market values have just as much difficulty in perceiving the future as any researcher. They, too, may only have crude estimates of the future income potential of land, and they may rely most heavily on the recent performance of land as their basis for appraising its future productivity (Locken et al, 1978).

One of the most difficult decisions required in using the income approach to valuation is choosing the appropriate capitalization rate. From a conceptual viewpoint, the capitalization rate should reflect the cost of capital or the cost of funds committed to the purchase of land. However, adjustments are necessary to reflect differences in the risk associated with land compared to alternative investments.

Reynolds and Timmons (1969) have suggested that the capitalization rate should reflect the rate of return on other farm inputs, thus representing the opportunity cost of investing in farmland. Scofield (1964) argues that one should employ rates of interest or rates of return on non-farm investments, which represent the opportunity cost of investing in any farm inputs. He argues that non-farm income producing real estate (such as apartment buildings and office complexes) or common stock has similar liquidity and risk characteristics, and is analogous to farmland in an investment sense. He objects, however, to the use of interest rates on real estate mortgages as a capitalization rate because they are a fixed monetary (Rand) investment.

Although Scofield (1964) argues that fixed monetary investments have a lower risk than farmland, rates of return on alternative investments may still be useful. It has been suggested that farmers as a group may use a lower capitalization rate because of a propensity for farming and a preference to live in a certain area (Reynolds and Timmons, 1969). On the basis of these arguments, the annual return on government bonds was selected as the capitalization rate. This is in accordance with the suggestions of Locken et al, (1978).

Empirical Results

Refinements were made to the numerator of the mentioned income-capitalization formula in order to measure other important factors which also influence the agricultural value of land. The refined formula involves $V = (I^* + S - E - L - i)/r$, where I^* = total expected cash farm receipts, S = services received by holding land, E = total cash farm expenses, L = the value of the operator's remuneration and unpaid family labor, i = interest on capital, and r = the capitalization rate.

Data on average agricultural income streams, total cash farm expenses and interest on capital ranging from 1970 to 1992, was obtained from the Directorate of Agricultural Economic Trends (1994), while the interest rate on government bonds was obtained from the Central Statistical Service (1994). Using this data, alternative regimes for expectations on returns per hectare were used to postulate future income streams. Extrapolative expectations on net returns per hectare were specified by extending a four-year trend. Adaptive expectations were specified following a geometric lag structure. These two approaches gave the best results in previous research on land markets in South Africa (Van Schalkwyk and Van Zyl, 1993), and are therefore also used here. Only the results of the adaptive expectations are shown since they provided the best results. Average salaries for all employees as reported by the Central Statistical Service were used to measure the value of operator's and unpaid family labor because actual figures were not available. Land provides its owner with free housing and water, cheaper food, etc (Binswanger and Deininger, 1993). The mentioned services, received by owning land, were measured by calculating the actual cost of these services if the operator had to pay for them. Figure A.11 compares

these calculated agricultural values of land with the market value of agricultural land.

Figure A.11 shows that the market and agricultural value of land followed almost the same trend since the 1960s. Agricultural values rose up to the mid seventies and then gradually declined. Figure A.11 emphasizes Van Wyk's (1976) finding that the difference between the market price and agricultural value in general increased during the period 1960 - 1969. However, it does also reveal that the difference between the market and agricultural value of land reached its maximum in 1984 after which it plummeted and reached a minimum in 1992, where the difference was insignificant. The agricultural value of land declined over the long-term. The market value of land, however, declined at a much faster pace, which caused the gap between the agricultural value and the market value of land to decrease.

Discussion

Inflation has become a major consideration in any investment or disinvestment decision. If buyers expect land to appreciate at a rate similar to the rate of inflation, they can expect to pay more for the same land at some future date. Consequently, if they have adequate financing and want to expand their land base, it may be desirable to make the land purchase now rather than to wait. For the seller, inflation is also an important consideration. Sellers must be careful not to lock themselves into fixed or constant income investments where the income stream and the investment principle do not adjust with inflation or increase with the general price level.

According to the previous analysis, the major force in the 1971 take-off period in land market prices of land was the opportunity rate of returns on capital. From 1968 to 1974, the real rate of return on savings dropped from 4.6 percent with 6.5 percent to–1.9 percent. This caused investment in land to become more attractive by comparison. Following the 1971 take-off period, much of the ensuing land market price appreciation was due to the 1968 to 1974 effects working through the system and culminating in price expectations effects. While, on the surface, this explanation may suggest that land market price changes are being explained tautologically, the adjustment process actually works much like a Nerlovian model. Each external shock has a declining distribution of effects over time reflected through land market price expectations, which is a lagged form of market land price. By 1979, opportunity cost had returned to pre-1968 extremes, but this time coupled with an added high inflation rate. Land market prices started to drop in 1977–a direct effect of the high inflation rate. Furthermore, the land market price volatility in the 1980s led to large increases in perceived risk tending to decrease market prices further.

The agricultural value of land on the other hand is affected by the ability of land to generate profits. Van Zyl et al (1993) showed that profits are mainly affected by changes in productivity and price recovery: from 1947 to 1991 total factor productivity increased rather slowly at 1.3 percent per annum; there was no growth until 1965; then 2.15 percent until 1981 and fairly rapid growth of 2.88 percent per annum since 1981. They also showed that land productivity increased at 3.13 percent per annum since 1947. The increasing rate of growth over the period is in accordance with Van Zyl and Groenewald's (1988) perception that farmer's profits came under increasing pressure as inflation gathered pace.

Since 1974, highly inflationary conditions prevailed. Input prices have risen faster than product prices and a cost price squeeze has been experienced. This cost-price squeeze obviously exerts considerable pressure on the income and therefore also on the agricultural value of land. Real net farm income has increased by nearly 181 percent since 1947. Van Zyl et al (1993) has ascribed this to the growth in total factor productivity of nearly 161 percent, which countered the decline of 27 percent in terms of trade. However, real net farm income declined by 1.06 percent per annum from 1973 until 1991, and by 8.14 percent from 1973 to 1983. This decline is a direct result of the unfavorable growth rate in the terms of trade.

It is evident from the above that inflation had a negative effect on both the market value and the agricultural value of land. This, coupled with the withdrawal of some of the major support services and policy distortions from the state to the farming

community, led to the general misconception that the difference between the market and agricultural value of land did not decline, but that at best it stayed the same. However, the effect of the fairly rapid growth in productivity which countered the negative effect of the terms of trade on profits and hence on agricultural values, were never taken into account. The growth in productivity did in fact push up net farm incomes, and hence also agricultural values, which resulted in a declining market/agricultural land value gap.

A.5 CONCLUSION

This appendix analyzed agricultural land prices in South Africa over time, including the sources of change and the difference between the market and agricultural value of land in South Africa. From the analysis, is it clear that the gap between the average market and agricultural value of South African land showed a general decline since 1984. The decline is attributable to the withdrawal of some of the major privileges benefiting the commercial farming community, and inflationary conditions which had a negative influence both on sellers and buyers, as well as an annual growth in productivity of 4.63 percent since 1983. This had a positive effect on agricultural land values, thus closing the gap between the market and agricultural value of land.

Appendix B

Maps of South Africa

1. **Median Annual Rainfall**
2. **Mean Annual Rainfall**
3. **Vegetation**
4. **Erodibility**
5. **Biological Production**
6. **Water Availability**
7. **Landscape**
8. **Land use**
9. **Population Density**
10. **Average Regional Output/Input Price Ratios**

Table C5.5: Calculation of the Resource Cost Ratios in Zone 5

	Maize (dryland	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Grain (dryland)	Grain (irr.)	Soya- (dryland)	Soya- (irr.)	Cotton (dryland)	Cotton (irr.)
Gross returns	1,572.15	2,515.44	1,652.61	4,957.83	2,841.45	4,546.32	1,653.17	3,857.39	2,484.76	4,969.53
Tradable component:										
Fixed costs	174.64	411.80	167.47	794.30	155.85	753.28	160.66	733.86	167.53	820.69
Variable machinary costs		116.52	460.46	129.68	399.39	113.03	380.12	120.07	281.50	132.72
624.42										
Purchased inputs	728.73	948.34	431.47	753.98	535.52	836.83	469.02	539.21	402.05	466.20
Transport	79.46	128.04	39.60	102.60	138.60	134.60	23.76	50.16	23.43	44.88
Contract services	188.10	188.10	152.95	152.95	163.40	163.40	152.95	152.95	0.00	98.80
Value added	284.70	378.69	731.44	2,754.61	1,735.05	2,278.10	726.70	2,099.71	1,759.03	2,914.53
Cost of domestic resources:										
Labor	68.63	121.21	46.49	112.75	29.98	33.44	18.31	24.61	649.62	1,005.53
Capital	138.56	218.65	72.84	128.92	83.86	154.70	73.73	97.49	88.18	139.22
Component of tradables:										
Fixed costs	65.48	75.17	26.13	93.75	48.89	104.74	60.03	158.97	37.48	100.51
Variable machinary costs		59.86	130.47	66.43	120.76	58.48	102.45	67.61	86.13	68.31
156.48										
Purchased inputs	166.83	219.43	90.75	164.05	133.07	208.39	96.90	102.24	91.49	107.53
Transport	52.98	85.36	26.40	68.40	92.40	89.73	15.84	33.44	15.62	29.92
Contract services	9.90	9.90	8.05	8.05	8.60	8.60	8.05	8.05	0.00	5.20
Land and water	2,056.31	2,056.31	2,056.31	1,587.66	2,056.31	2,056.31	2,056.31	2,056.31	2,056.31	2,056.31
Total cost of domestic resources	2,618.55	2,916.51	2,393.41	2,284.33	2,511.59	2,758.37	2,396.79	2,567.24	3,007.01	3,600.70
Resource cost ratio	9.20	7.70	3.27	0.83	1.45	1.21	3.30	1.22	1.71	1.24

Table C6.1: Technical Coefficients in Zone 6

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flowers (dryland)	Grain Sorghum (dryland)	Soya-beans (dryland)	Soya-beans (irr.)
Gross returns:											
Yield	t	3.00	8.00	1.80	4.50	1.80	1.60	1.20	3.00	1.69	2.40
Straw	t	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Purchased inputs:											
Seed	kg	10.00	15.00	30.00	130.00	35.00	1.00	5.00	5.00	50.00	70.00
2-4D Amine	l	0.00	0.00	0.00	0.00	35.00	0.00	0.00	0.00	0.00	0.00
2:3:2 (22)+Zn	kg	0.00	100.00	0.00	100.00	800.00	0.00	0.00	0.00	0.00	0.00
2:3:4 (30)+Zn	kg	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
2:3:4 (33).5%Zn-Cl	kg	0.00	0.00	0.00	0.00	0.00	500.00	0.00	0.00	0.00	0.00
3:1:5 (38)	kg	100.00	100.00	120.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LAN	kg	120.00	0.00	0.00	0.00	200.00	0.00	0.00	0.00	0.00	0.00
Lime	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
Potashuim nitrate	kg	0.00	0.00	0.00	0.00	0.00	150.00	0.00	0.00	100.00	0.00
Superphosphate	kg	0.00	0.00	0.00	0.00	0.00	500.00	100.00	75.00	250.00	0.00
U.A.N. (32) Opl	kg	0.00	280.00	0.00	250.00	0.00	0.00	0.00	0.00	0.00	0.00
Accotab	kg	0.00	0.75	200.00	0.00	0.00	4.03	0.00	0.00	0.00	0.00
Atrazine	l	3.25	1.50	0.00	0.00	0.00	0.00	0.00	1.33	0.00	0.00
Banvel	kg	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
Buctril	l	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00
Chrotofos	kg	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00
Cumicidin	ml	0.00	16.60	0.00	0.00	0.00	0.00	0.00	180.00	0.00	0.00
Curaterr	kg	0.00	0.00	0.00	0.00	13.00	0.00	0.00	0.00	0.00	0.00
Cybermethrin	l	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Decca	l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.15
Dip seed	g	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	1.50
Dursban	l	0.00	0.00	0.00	0.00	0.00	1.08	0.00	0.00	0.00	0.00
Duthane	kg	0.00	0.00	0.00	0.00	14.00	0.00	0.00	0.00	0.00	0.00
EDB	l	0.00	0.00	0.00	0.00	0.00	40.00	0.00	0.00	0.00	0.00
EDB fumagate	l	0.00	0.00	0.00	0.00	30.00	0.00	0.00	0.00	0.00	0.00
Folidol	l	0.00	0.00	0.00	0.75	0.00	0.00	0.00	1.00	0.00	0.00
Monocrotofos	l	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gusathion	ml	0.00	0.00	0.00	0.00	780.00	0.00	0.00	0.00	0.00	0.00
Karbadust	l	0.00	0.00	0.00	0.00	0.00	35.00	0.00	0.00	0.00	0.00
Orthene	kg	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00
Ramrod	kg	3.25	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00

Table C6.1: Technical Coefficients in Zone 6, continued

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flowers (dryland)	Grain Sorghum (dryland)	Soya-beans (dryland)	Soya-beans (irr.)
Rogor	l	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00
Spoormix	kg	50.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	5.00	0.00
Stomp	l	0.00	0.00	0.00	0.00	0.00	2.00	3.00	0.00	0.00	0.00
Sumicidin	l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tamaron	ml	0.00	0.00	0.00	0.00	500.00	0.00	2.00	0.00	0.00	0.00
Thiodan M.O.	l	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00
Triff 480	l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.50	0.00
Bags	bag	0.00	0.00	0.00	0.00	1,800.00	0.00	0.00	0.00	24.00	0.00
Cole	kg	0.00	0.00	0.00	0.00	0.00	3,255.00	0.00	0.00	0.00	0.00
Packaging material	toll	0.00	0.00	0.00	3.60	0.00	0.00	0.00	0.00	0.18	0.00
Contract/hire services:											
Contract airspray	ha	0.00	1.00	1.00	1.00	1,800.00	1.00	0.00	0.00	0.00	1.00
Contract harvest/t	ha	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	2.40
Contract transport	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40
Machinery:											
Diesel	l	50.62	74.91	37.94	77.66	207.94	165.20	49.72	41.41	101.48	37.16
Implements	hours	3.75	4.51	3.76	7.11	22.73	15.64	5.87	5.63	8.56	5.73
Electricity	Kw.h	0.00	3,250.00	0.00	2,916.67	0.00	605.00	0.00	0.00	0.00	440.00
Irrigation: engine&pump	mm	0.00	108.33	0.00	104.17	0.00	605.00	0.00	0.00	0.00	440.00
Electricity (dry)	mm	0.00	0.00	0.00	0.00	0.00	5,184.00	0.00	0.00	0.00	0.00
Fixed cost: Machinery											
Hail insurance	ha	1.00	1.00	1.00	1.00	0.00	1.00	0.00	1.00	1.00	1.00
Labor:											
Harvesting	hour	1.00	0.00	0.00	1.00	8.33	0.00	0.00	0.00	0.00	90.00
Machinery	hour	7.18	13.46	4.96	11.02	41.95	27.93	9.37	7.64	15.94	10.57
Irrigation	hour	0.00	25.88	0.00	90.00	0.00	42.00	0.00	0.00	0.00	18.00
Load	hour	1.00	1.00	0.00	0.00	5.00	5.00	0.00	0.00	3.16	1.70
Off load	hour	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pest control	hour	0.00	0.00	0.00	0.00	0.00	945.00	0.00	0.00	0.00	0.00
Irrigation	hour	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00
Fertilizer	hour	0.00	0.00	0.00	0.00	0.00	48.00	0.00	0.00	0.00	0.00
Sort	hour	0.00	0.00	0.00	0.00	13.30	0.00	0.00	0.00	0.00	0.00
Cultivate/Plant	hour	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.70
Lift and fill	hour	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00
Additional labor	hour	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest on op. capital	Rand	331.93	1,103.71	225.64	806.85	2,167.98	2,162.60	115.84	212.78	698.24	453.03

Table C6.2: Costs and Prices in Zone 6 (Rand/unit)

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flowers (dryland)	Grain Sorghum (dryland)	Soya-beans (dryland)	Soya-beans (irr.)
Gross returns :											
Yield	t	370.00	370.00	742.68	742.68	552.00	1,065.00	878.00	330.00	839.0	839.00
Straw	t	0.00	0.00	0.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00
Purchased inputs:											
Seed	kg	6.00	6.00	1.72	1.72	34.00	605.55	11.80	5.60	3.28	2.48
2-4D Amine	l	0.00	0.00	0.00	0.00	2.21	0.00	0.00	0.00	0.00	0.00
2:3:2 (22)+Zn	kg	0.00	1.07	0.00	0.78	1.07	0.00	0.00	0.00	0.00	0.00
2:3:4 (30)+Zn	kg	0.00	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00
2:3:4 (33).5%Zn-Cl	kg	0.00	0.00	0.00	0.00	0.00	1.18	0.00	0.00	0.00	0.00
3:1:5 (38)	kg	0.84	1.04	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LAN	kg	0.70	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00
Lime	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.00	0.00
Potashuim nitrate	kg	0.00	0.00	0.00	0.00	0.00	1.73	0.00	0.00	0.96	0.00
Superphosphate	kg	0.00	0.00	0.00	0.00	0.00	0.65	0.64	0.64	0.73	0.00
U.A.N. (32) Opl	l	0.00	0.77	0.00	0.77	0.00	0.00	0.00	0.00	0.00	0.00
Accotab	kg	0.00	27.54	0.01	0.00	0.00	54.30	0.00	0.00	0.00	0.00
Atrazine	l	14.20	14.20	0.00	0.00	0.00	0.00	0.00	14.20	0.00	0.00
Banvel	kg	0.00	86.17	0.00	86.17	0.00	0.00	0.00	0.00	0.00	61.76
Buctril	l	0.00	0.00	0.00	61.79	0.00	0.00	0.00	0.00	0.00	0.00
Chrotofos	kg	0.00	0.00	0.00	0.00	0.00	14.15	0.00	0.00	0.00	0.00
Cimicidin	ml	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00
Curaterr	kg	0.00	0.00	0.00	0.00	13.28	0.00	0.00	0.00	0.00	0.00
Cybermethrin	l	0.00	0.00	0.00	97.14	0.00	0.00	0.00	0.00	0.00	0.00
Decca	l	0.00	0.00	0.00	0.00	0.00	12.65	0.00	0.00	68.64	86.12
Dip seed	g	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	89.25	56.69
Dursban	l	0.00	0.00	0.00	0.00	0.00	64.70	0.00	0.00	0.00	0.00
Duthane	kg	0.00	0.00	0.00	0.00	16.66	0.00	0.00	0.00	0.00	0.00
EDB	l	0.00	0.00	0.00	0.00	0.00	16.48	0.00	0.00	0.00	0.00
EDB fumagate	l	0.00	0.00	0.00	0.00	15.31	0.00	0.00	0.00	0.00	0.00
Folidol	l	0.00	0.00	0.00	18.09	0.00	0.00	0.00	18.09	0.00	0.00
Gusathion	ml	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Karbadust	l	0.00	0.00	0.00	0.00	0.00	5.14	0.00	0.00	0.00	0.00
Monocrotophos	l	22.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthene	kg	0.00	0.00	0.00	0.00	0.00	84.40	0.00	0.00	0.00	0.00
Ramrod	kg	19.46	0.00	0.00	0.00	0.00	0.00	0.00	1.94	0.00	0.00
Rogor	l	0.00	0.00	0.00	0.00	0.00	23.60	0.00	0.00	0.00	0.00

Table C6.2: Costs and Prices in Zone 6 (Rand/unit), continued

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flowers (dryland)	Grain Sorghum (dryland)	Soya-beans (dryland)	Soya-beans (irr.)
Spoormix	kg	0.13	0.00	0.00	0.00	0.00	0.00	3.86	0.00	3.10	0.00
Stomp	l	0.00	0.00	0.00	0.00	0.00	76.13	9.45	0.00	0.00	0.00
Sumicidin	l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tamaron	ml	0.00	0.00	0.00	0.00	0.04	0.00	21.97	0.00	0.00	0.00
Thiodan M.O.	l	0.00	0.00	0.00	0.00	0.00	33.60	0.00	0.00	0.00	0.00
Triff 480	l	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Bags	bag	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.00	2.80	0.00
Cole	kg	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00
Packaging material	toll	0.00	0.00	0.00	10.52	0.00	0.00	0.00	0.00	7.19	0.00
Contract/hire services:											
Contract airspray	ha	0.00	26.00	26.00	26.00	0.85	45.00	0.00	0.00	0.00	45.00
Contract harvest/t	ha	0.00	0.00	0.00	80.00	0.00	0.00	0.00	0.00	0.00	40.00
Contract transport	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	90.00
Machinery:											
Diesel	l	1.46	1.46	1.46	1.46	1.46	1.54	1.46	1.46	1.54	1.54
Implements	hours	4.45	6.09	4.87	7.96	3.39	2.84	4.60	3.90	4.87	4.14
Electricity	Kw.h	0.00	0.14	0.00	0.14	0.00	0.18	0.00	0.00	0.00	0.62
Irrigation: engine&pump	mm	0.00	0.21	0.00	0. 21	0.00	0.03	0.00	0.00	0.00	0.03
Electricity	mm	0.00	0.00	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.00
Fixed cost: Machinery											
Hail insurance	ha	37.62	89.76	84.22	350.92	0.00	2,268.50	0.00	45.54	232.71	83.58
Labor:											
Harvesting	hour	1.20	0.00	0.00	2.00	4.00	0.00	0.00	1.20	0.00	1.30
Machinery	hour	1.63	1.60	1.70	1.64	1.63	1.62	1.64	1.62	1.63	1.56
Irrigation	hour	0.00	1.44	0.00	1.44	0.00	1.44	0.00	0.00	0.00	1.30
Load	hour	1.20	10.00	0.00	0.00	7.00	1.30	0.00	6.00	1.10	1.30
Off load	hour	1.20	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00
Pest control	hour	0.00	0.00	0.00	10.00	0.00	1.30	0.00	0.00	0.00	0.00
Irrigation	hour	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44
Fertilizer	hour	0.00	0.00	0.00	0.00	0.00	1.30	0.00	0.00	0.00	0.00
Sort	hour	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00
Cultivate/Plant	hour	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	1.30
Lift and fill	hour	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	0.00
Additional labor	hour	0.00	0.00	0.00	2.20	0.00	0.00	0.00	0.00	0.00	0.00
Interest on op. capital	Rand	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

Table C6.3: Market Prices in Zone 6 (Rand/ha)

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flowers (dryland)	Grain Sorghum (irr.)	Soya-beans (dryland)	Soya-beans (irr.)
Gross returns :											
Yield	Rand	1,110.00	2,960.00	1,336.82	3,342.06	9,936.00	17,040.00	1,053.60	990.00	1,417.91	2,013.60
Straw	Rand	0.00	0.00	0.00	250.00	0.00	0.00	0.00	0.00	0.00	0.00
Total receipts	Rand	1,110.00	2,960.00	1336.82	3,592.06	9,936.00	17,040.00	1,053.60	990.00	1,417.91	2,013.60
Purchased inputs:											
Seed	Rand	60.00	90.00	51.60	223.60	1,190.00	605.55	59.00	28.00	164.00	173.60
2-4D Amine	Rand	0.00	0.00	0.00	0.00	77.35	0.00	0.00	0.00	0.00	0.00
2:3:2 (22)+Zn	Rand	0.00	106.80	0.00	77.50	852.80	0.00	0.00	0.00	0.00	0.00
2:3:4 (30)+Zn	Rand	0.00	0.00	0.00	97.70	0.00	0.00	0.00	0.00	0.00	0.00
2:3:4 (33).5%Zn-Cl	Rand	0.00	0.00	0.00	0.00	0.00	590.00	0.00	0.00	0.00	0.00
3:1:5 (38)	Rand	84.10	104.00	124.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LAN	Rand	84.00	0.00	0.00	0.00	140.00	0.00	0.00	0.00	0.00	0.00
Lime	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.00	0.00
Potassium nitrate	Rand	0.00	0.00	0.00	0.00	0.00	259.50	0.00	0.00	96.00	0.00
Superphosphate	Rand	0.00	0.00	0.00	0.00	0.00	325.00	63.60	47.70	182.50	0.00
U.A.N. (32) Opl	Rand	0.00	216.72	0.00	193.50	0.00	0.00	0.00	0.00	0.00	0.00
Accotab	Rand	0.00	20.66	1.00	0.00	0.00	218.83	0.00	0.00	0.00	0.00
Atrazine	Rand	46.13	21.29	0.00	0.00	0.00	0.00	0.00	18.88	0.00	0.00
Banvel	Rand	0.00	30.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	123.52
Buctril	Rand	0.00	0.00	0.00	92.69	0.00	0.00	0.00	0.00	0.00	0.00
Chrotofos	Rand	0.00	0.00	0.00	0.00	0.00	84.90	0.00	0.00	0.00	0.00
Cimicidin	Rand	0.00	2.19	0.00	0.00	0.00	0.00	0.00	23.76	0.00	0.00
Curaterr	Rand	0.00	0.00	0.00	0.00	172.64	0.00	0.00	0.00	0.00	0.00
Cybermethrin	Rand	0.00	0.00	0.00	12.14	0.00	0.00	0.00	0.00	0.00	0.00
Decca	Rand	0.00	0.00	0.00	0.00	0.00	262.61	0.00	0.00	68.64	12.92
Dip seed	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.93	85.03
Dursban	Rand	0.00	0.00	0.00	0.00	0.00	69.88	0.00	0.00	0.00	0.00
Duthane	Rand	0.00	0.00	0.00	0.00	233.24	0.00	0.00	0.00	0.00	0.00
EDB	Rand	0.00	0.00	0.00	0.00	0.00	659.20	0.00	0.00	0.00	0.00
EDB fumagate	Rand	0.00	0.00	0.00	0.00	459.30	0.00	0.00	0.00	0.00	0.00

Table C6.3: Market Prices in Zone 6 (Rand/ha), continued

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flowers (dryland)	Grain Sorghum (irr.)	Soya-beans (dryland)	Soya-beans (irr.)
Folidol	Rand	0.00	0.00	0.00	13.57	0.00	0.00	0.00	18.09	0.00	0.00
Gusathion	Rand	0.00	0.00	0.00	0.00	34.32	0.00	0.00	0.00	0.00	0.00
Karbadust	Rand	0.00	0.00	0.00	0.00	0.00	179.90	0.00	0.00	0.00	0.00
Monocrotophos	Rand	14.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthene	Rand	0.00	0.00	0.00	0.00	0.00	168.80	0.00	0.00	0.00	0.00
Ramrod	Rand	63.24	0.00	0.00	0.00	0.00	0.00	0.00	11.65	0.00	0.00
Rogor	Rand	0.00	0.00	0.00	0.00	0.00	18.88	0.00	0.00	0.00	0.00
Spoormix	Rand	6.35	0.00	0.00	0.00	0.00	0.00	19.30	0.00	15.50	0.00
Stomp	Rand	0.00	0.00	0.00	0.00	0.00	152.26	28.35	0.00	0.00	0.00
Sumicidin	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tamaron	Rand	0.00	0.00	0.00	0.00	19.50	0.00	43.94	0.00	0.00	0.00
Thiodan M.O.	Rand	0.00	0.00	0.00	0.00	0.00	336.00	0.00	0.00	0.00	0.00
Triff 480	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00
Bags	Rand	0.00	0.00	0.00	0.00	684.00	0.00	0.00	0.00	67.20	0.00
Cole	Rand	0.00	0.00	0.00	0.00	0.00	585.90	0.00	0.00	0.00	0.00
Packaging material	Rand	0.00	0.00	0.00	37.87	0.00	0.00	0.00	0.00	1.29	0.00
Contract/hire services:											
Contract airspray	Rand	0.00	26.00	26.00	26.00	1,530.00	45.00	0.00	0.00	0.00	45.00
Contract harvest/t	Rand	0.00	0.00	0.00	80.00	0.00	0.00	0.00	0.00	0.00	96.00
Contract transport	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	216.00
Machinery:											
Diesel	Rand	73.91	109.37	55.39	113.38	303.59	254.41	72.59	60.46	156.28	57.23
Implements	Rand	16.69	27.47	18.31	56.60	77.05	44.42	27.00	21.96	41.69	23.72
Repairs	Rand	72.63	98.64	58.87	16.16	305.20	156.63	77.28	62.97	114.53	44.02
Electricity	Rand	0.00	455.00	0.00	408.33	0.00	933.12	0.00	0.00	0.00	272.80
Irrigation: engine&pump	Rand	0.00	22.75	0.00	21.88	0.00	18.15	0.00	0.00	0.00	13.20
Electricity (dry)	Rand	0.00	0.00	0.00	0.00	0.00	375.10	0.00	0.00	0.00	0.00
Repairs(center pivot)	Rand	0.00	0.17	0.00	11.89	0.00	17.47	0.00	0.00	0.00	17.47
Fixed cost: Machinery											
Tractor/tillage	Rand	59.45	285.89	55.45	471.04	328.10	525.10	80.76	60.97	131.50	378.08
Combine	Rand	30.40	36.17	24.18	12.49	0.00	0.00	34.55	31.36	25.72	0.00

Table C6.3: Market Prices in Zone 6 (Rand/ha), continued

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flowers (dryland)	Grain Sorghum (irr.)	Soya-beans (dryland)	Soya-beans (irr.)
Interest	Rand	89.85	309.11	79.68	477.31	328.57	537.39	115.31	92.27	158.70	365.07
Hail insurance	Rand	37.62	89.76	84.22	350.92	0.00	2,268.50	0.00	45.54	232.71	83.58
Labor:											
Harvesting	Rand	1.20	0.00	0.00	2.00	33.32	0.00	0.00	0.00	0.00	117.00
Machinery	Rand	11.70	21.54	8.43	18.07	68.38	45.25	15.37	12.38	25.98	16.49
Irrigation	Rand	0.00	37.26	0.00	129.60	0.00	60.48	0.00	0.00	0.00	23.40
Load	Rand	1.20	10.00	0.00	0.00	35.00	6.50	0.00	0.00	3.48	2.21
Off load	Rand	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pest control	Rand	0.00	0.00	0.00	0.00	0.00	1,228.50	0.00	0.00	0.00	0.00
Irrigation	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.20
Fertilizer	Rand	0.00	0.00	0.00	0.00	0.00	62.40	0.00	0.00	0.00	0.00
Sort	Rand	0.00	0.00	0.00	0.00	53.20	0.00	0.00	0.00	0.00	0.00
Cultivate/Plant	Rand	0.00	0.00	0.00	0.00	6.40	0.00	0.00	0.00	0.00	0.91
Lift and fill	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.80	0.00
Additional labor	Rand	0.00	0.00	0.00	2.20	0.00	0.00	0.00	0.00	0.00	0.00
Interest on op. capital	Rand	50.45	167.76	34.30	122.64	329.53	328.72	17.61	32.34	106.13	68.86
Total cost	Rand	805.06	2,288.70	622.23	3,069.08	7,261.50	11,424.34	654.66	568.33	1,673.07	2,279.31
Net returns to land and water	Rand	304.94	671.30	714.59	522.98	2,674.50	5,615.66	398.94	421.67	-255.16	-265.71

Table C6.4: Economic Prices in Zone 6 (No Shadow Exchange Rate) (Rand/ha)

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flower (dryland)	Grain Sorghum (irr.)	Soya-beans (dryland)	Soya-beans (irr.)
Gross returns :											
Yield	Rand	873.69	2,082.32	1,550.60	3,975.05	9,936.00	17,233.92	1,816.94	1,742.49	2,348.84	3,011.73
Straw	Rand	0.00	0.00	0.00	250.00	0.00	0.00	0.00	0.00	0.00	0.00
Total receipts:	Rand	873.69	2,082.32	1,550.60	4,225.05	9,936.00	17,233.92	1,816.94	1,742.49	2,348.84	3011.73
Purchased inputs:											
Seed	Rand	60.00	90.00	0.00	223.60	1,190.00	605.55	59.00	28.00	164.00	173.60
2-4D Amine	Rand	0.00	0.00	0.00	0.00	77.35	0.00	0.00	0.00	0.00	0.00
2:3:2 (22)+Zn	Rand	0.00	106.80	0.00	77.50	852.80	0.00	0.00	0.00	0.00	0.00
2:3:4 (30)+Zn	Rand	0.00	0.00	0.00	97.70	0.00	0.00	0.00	0.00	0.00	0.00
2:3:4 (33).5%Zn-Cl	Rand	0.00	0.00	0.00	0.00	0.00	590.00	0.00	0.00	0.00	0.00
3:1:5 (38)	Rand	84.10	104.00	124.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LAN	Rand	84.00	0.00	0.00	0.00	140.00	0.00	0.00	0.00	0.00	0.00
Lime	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.00	0.00
Potassium nitrate	Rand	0.00	0.00	0.00	0.00	0.00	259.50	0.00	0.00	96.00	0.00
Superphosphate	Rand	0.00	0.00	0.00	0.00	0.00	325.00	63.60	47.70	182.50	0.00
U.A.N. (32) Opl	Rand	0.00	216.72	0.00	193.50	0.00	0.00	0.00	0.00	0.00	0.00
Accotab	Rand	0.00	18.78	0.91	0.00	0.00	198.94	0.00	0.00	0.00	0.00
Atrazine	Rand	41.94	19.36	0.00	0.00	0.00	0.00	0.00	17.16	0.00	0.00
Banvel	Rand	0.00	27.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	112.29
Buctril	Rand	0.00	0.00	0.00	84.26	0.00	0.00	0.00	0.00	0.00	0.00
Chrotofos	Rand	0.00	0.00	0.00	0.00	0.00	77.18	0.00	0.00	0.00	0.00
Cimicidin	Rand	0.00	1.99	0.00	0.00	0.00	0.00	0.00	21.60	0.00	0.00
Curaterr	Rand	0.00	0.00	0.00	0.00	156.95	0.00	0.00	0.00	0.00	0.00
Cybermethrin	Rand	0.00	0.00	0.00	11.04	0.00	0.00	0.00	0.00	0.00	0.00
Decca	Rand	0.00	0.00	0.00	0.00	0.00	238.74	0.00	0.00	62.40	11.74
Dip seed	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.11	77.30
Dursban	Rand	0.00	0.00	0.00	0.00	0.00	63.52	0.00	0.00	0.00	0.00
Duthane	Rand	0.00	0.00	0.00	0.00	212.04	0.00	0.00	0.00	0.00	0.00
EDB	Rand	0.00	0.00	0.00	0.00	0.00	599.27	0.00	0.00	0.00	0.00
EDB fumagate	Rand	0.00	0.00	0.00	0.00	417.55	0.00	0.00	0.00	0.00	0.00

Table C6.4: Economic Prices in Zone 6 (No Shadow Exchange Rate) (Rand/ha), continued

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flower (dryland)	Grain Sorghum (irr.)	Soya-beans (dryland)	Soya-beans (irr.)
Folidol	Rand	0.00	0.00	0.00	12.33	0.00	0.00	0.00	16.45	0.00	0.00
Gusathion	Rand	0.00	0.00	0.00	0.00	31.20	0.00	0.00	0.00	0.00	0.00
Karbadust	Rand	0.00	0.00	0.00	0.00	0.00	163.55	0.00	0.00	0.00	0.00
Monocrotophos	Rand	13.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthene	Rand	0.00	0.00	0.00	0.00	0.00	153.45	0.00	0.00	0.00	0.00
Ramrod	Rand	57.50	0.00	0.00	0.00	0.00	0.00	0.00	10.59	0.00	0.00
Rogor	Rand	0.00	0.00	0.00	0.00	0.00	17.16	0.00	0.00	0.00	0.00
Spoormix	Rand	5.77	0.00	0.00	0.00	0.00	0.00	17.55	0.00	14.09	0.00
Stomp	Rand	0.00	0.00	0.00	0.00	0.00	138.42	25.77	0.00	0.00	0.00
Sumicidin	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tamaron	Rand	0.00	0.00	0.00	0.00	17.73	0.00	39.95	0.00	0.00	0.00
Thiodan M.O.	Rand	0.00	0.00	0.00	0.00	0.00	305.45	0.00	0.00	0.00	0.00
Triff 480	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00
Bags	Rand	0.00	0.00	0.00	0.00	621.82	0.00	0.00	0.00	61.09	0.00
Cole	Rand	0.00	0.00	0.00	0.00	0.00	532.64	0.00	0.00	0.00	0.00
Packaging material	Rand	0.00	0.00	0.00	37.87	0.00	0.00	0.00	0.00	1.29	0.00
Contract/hire services:											
Contract airspray	Rand	0.00	26.00	26.00	26.00	1,530.00	45.00	0.00	0.00	0.00	45.00
Contract harvest/t	Rand	0.00	0.00	0.00	80.00	0.00	0.00	0.00	0.00	0.00	96.00
Contract transport	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	216.00
Machinery:											
Diesel	Rand	49.52	73.28	0.00	75.97	203.41	170.45	48.64	40.51	104.71	38.34
Implements	Rand	16.69	27.47	0.00	56.60	77.05	44.42	27.00	21.96	41.69	23.72
Repairs	Rand	69.17	93.94	0.00	15.39	290.67	149.17	73.60	59.97	109.08	41.92
Electricity	Rand	0.00	573.30	0.00	514.50	0.00	1,175.73	0.00	0.00	0.00	343.73
Irrigation: engine&pump	Rand	0.00	22.75	0.00	21.88	0.00	18.15	0.00	0.00	0.00	13.20
Electricity	Rand	0.00	0.00	0.00	0.00	0.00	472.63	0.00	0.00	0.00	0.00
Repairs(center pivot)	Rand	0.00	0.17	0.00	11.89	0.00	17.47	0.00	0.00	0.00	17.47
Fixed cost: Machinery											
Tractor/tillage	Rand	40.13	258.90	39.43	439.03	231.84	465.53	60.10	43.82	87.56	360.98
Combine	Rand	30.40	36.17	24.18	12.49	0.00	0.00	34.55	31.36	25.72	0.00
Interest	Rand	75.34	284.60	64.79	444.33	242.02	469.62	105.16	76.71	115.85	349.49
Hail insurance	Rand	37.62	89.76	84.22	350.92	0.00	2,268.50	0.00	45.54	232.71	83.58

Table C6.4: Economic Prices in Zone 6 (No Shadow Exchange Rate) (Rand/ha), continued

	Units/ha	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flower (dryland)	Grain Sorghum (irr.)	Soya-beans (dryland)	Soya-beans (irr.)
Labor:											
Harvesting	Rand	1.20	0.00	0.00	2.00	33.32	0.00	0.00	0.00	0.00	117.00
Machinery	Rand	11.70	21.54	0.00	18.07	68.38	45.25	15.37	12.38	25.98	16.49
Irrigation	Rand	0.00	22.69	0.00	78.93	0.00	36.83	0.00	0.00	0.00	14.25
Load	Rand	0.73	6.09	0.00	0.00	21.32	3.96	0.00	0.00	2.12	1.35
Off load	Rand	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pest control	Rand	0.00	0.00	0.00	0.00	0.00	748.16	0.00	0.00	0.00	0.00
Irrigation	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.31
Fertilizer	Rand	0.00	0.00	0.00	0.00	0.00	38.00	0.00	0.00	0.00	0.00
Sort	Rand	0.00	0.00	0.00	0.00	32.40	0.00	0.00	0.00	0.00	0.00
Cultivate/Plant	Rand	0.00	0.00	0.00	0.00	3.90	0.00	0.00	0.00	0.00	0.55
Lift and fill	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.36	0.00
Additional labor	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest on op. capital	Rand	50.45	167.76	0.00	122.64	329.53	328.72	17.61	32.34	106.13	68.86
Total cost	Rand	730.57	2,289.48	364.33	3,008.43	6,781.25	10,765.96	587.89	506.09	1,509.84	2,249.18
Net returns to land and water	Rand	143.12	-207.16	1,186.27	1,216.62	3,154.75	6,467.96	1,229.05	1,236.40	839.00	762.54

Table C6.5: Calculation of the Resource Cost Ratios in Zone 6

	Maize (dryland)	Maize (irr.)	Wheat (dryland)	Wheat (irr.)	Potato (dryland)	Tobacco (irr.)	Sun-flowers (dryland)	Grain Sorghum (irr.)	Soya-beans (dryland)	Soya-beans (irr.)
Gross returns	873.69	2,082.32	1,550.60	4,225.05	9,936.00	17,233.92	1,816.94	1,742.49	2,348.84	3,011.73
Tradable component:										
Fixed costs	153.62	586.59	155.67	991.43	450.17	1,795.79	189.82	162.51	310.76	708.38
Variable machinery cost	87.49	625.42	0.00	558.57	366.93	1,503.70	94.07	77.42	169.62	374.83
Purchased inputs	283.50	477.05	100.57	616.39	3,155.12	3,528.52	170.59	116.00	544.99	317.31
Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Contract services	0.00	24.70	24.70	100.70	1,453.50	42.75	0.00	0.00	0.00	339.15
Value added	349.07	368.56	1,269.66	1,957.96	4,510.29	10,363.16	1,362.45	1,386.56	1,323.47	1,272.05
Cost of domestic resources:										
Labor	14.37	50.32	0.00	99.00	159.31	872.20	15.37	12.38	33.46	175.95
Capital	50.45	167.76	0.00	122.64	329.53	328.72	17.61	32.34	106.13	68.86
Component of tradables:										
Fixed costs	29.87	82.84	56.95	255.34	23.69	1,407.86	9.99	34.92	151.08	85.67
Variable machinery cost	47.88	157.46	0.00	125.83	204.20	366.44	55.16	45.01	85.85	92.82
Purchased inputs	63.38	108.01	2 5.14	121.41	624.48	739.86	35.27	25.50	114.06	57.63
Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Contract services	0.00	1.30	1.30	5.30	76.50	2.25	0.00	0.00	0.00	17.85
Land and water	1,236.40	1,236.40	1,236.40	1,236.40	1,236.40	1,236.40	1,236.40	1,229.05	1,236.40	1,236.40
Total cost of domestic resources	1,442.34	1,804.10	1,319.79	1,965.93	2,654.12	4,953.71	1,369.80	1,379.20	1,726.98	1,735.18
Resource cost ratio	4.13	4.89	1.04	1.00	0.59	0.48	1.01	0.99	1.30	1.36

Appendix D: Livestock Production (Cattle and Sheep) by Zone

Table D1.1: Technical Coefficients for Beef Cattle

	Units/ha	Zone 1 Com-mercial	Zone 3 Com-mercial	Zone 3 Small scale	Zone 4 Com-mercial	Zone 4 Small scale	Zone 5 Com-mercial	Zone 5 Small scale	Zone 6 Com-mercial
Purchased inputs:									
Fattening ration	kg	962.00	21,600.00	0.00	0.00	0.00	1,981.00	0.00	0.00
Licks	kg	1,991.00	34,260.00	0.00	0.00	0.00	13,235.00	0.00	36,450.00
Salt	Bags	0.00	0.00	0.00	109.60	0.00	0.00	0.00	0.00
P12 Phosphate	Bags	138.00	0.00	0.00	111.20	0.00	0.00	0.00	0.00
Ureum	Bags	275.00	0.00	0.00	15.50	0.00	0.00	0.00	0.00
Vitamin complex	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
Vaccine	Dses	0.00	300.00	0.00	0.00	0.00	0.00	0.00	0.00
Medicine	Head	0.00	515.00	0.00	0.00	0.00	123.50	0.00	0.00
Dip	l	0.00	45.00	0.00	0.00	0.00	0.00	0.00	0.00
Botulinus	Dses	0.00	0.00	0.00	487.00	0.00	0.00	0.00	0.00
Splenic fever	Dses	0.00	0.00	0.00	487.00	0.00	0.00	0.00	0.00
Brucella	Dses	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.33
Deadline	l	2.80	0.00	0.00	0.00	0.00	0.00	0.00	52.50
Terramycin	ml	3.19	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Black quarter	Dses	0.00	0.00	0.00	366.00	0.00	0.00	0.00	1.47
Curatic	ml	0.00	0.00	0.00	1,000.00	0.00	0.00	0.00	0.00
Antrax	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26
Botulism	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53
Pastorella	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17
Enzoitic abortion	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22
Vibriose	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46
Valbazen	Dses	3.89	0.00	0.00	0.00	0.00	0.00	0.00	5.13
Replace bull	Head	0.00	4.00	0.00	1.17	0.00	0.00	0.00	1.00
Ear plates		0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.00
Contract/hire services:									
Contract transport	ha	36.50	327.00	0.00	1,100.00	0.00	78.24	0.00	114.00
Machinery:									
Diesel	l	0.00	221.76	0.00	7,473.91	0.00	0.00	0.00	2,357.00
Petrol	l	0.00	3.48	0.00	2,788.20	0.00	0.00	0.00	74.16

Table D1.1: Technical Coefficients for Beef Cattle, continued

	Units/ha	Zone 1 Com-mercial	Zone 3 Com-mercial	Zone 3 Small scale	Zone 4 Com-mercial	Zone 4 Small scale	Zone 5 Com-mercial	Zone 5 Small scale	Zone 6 Com-mercial
Implements	hours	0.00	36.00	0.00	0.00	0.00	0.00	0.00	0.00
Fixed cost: Machinery									
Insurance	t	5.84	54.83	0.00	28.80	0.00	0.00	0.00	0.00
Labor:									
Livestock	hour	840.00	11,484.00	0.00	504.00	0.00	1,920.00	0.00	5,280.00
Machinery	hour	0.00	44.14	0.00	2,927.93	0.00	1,920.00	0.00	0.00
Additional labour/small scale	hour	0.00	0.00	0.00	288.00	0.00	0.00	0.00	0.00
Interest on operating capital	Rand	950.42	19,684.14	19,684.14	12,826.31	12,826.31	1,000.00	1,000.00	14,928.79

Table D1.2: Costs and Prices for Beef Cattle (Rand/ha)

	Units/ha	Zone 1 Com-mercial	Zone 3 Com-mercial	Zone 3 Small scale	Zone 4 Com-mercial	Zone 4 Small scale	Zone 5 Com-mercial	Zone 5 Small scale	Zone 6 Com-mercial
Purchased inputs:									
Fattening ration	kg	0.37	0.73	0.00	0.00	0.00	15.00	0.00	0.00
Licks	kg	1.11	0.66	0.00	0.00	0.00	0.69	0.00	0.80
Salt	Bags	0.00	0.00	0.00	8.55	0.00	0.00	0.00	0.00
P12 Phosphate	Bags	0.77	0.00	0.00	50.90	0.00	0.00	0.00	0.00
Ureum	Bags	1.67	0.00	0.00	49.87	0.00	0.00	0.00	0.00
Vitamin complex	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	395.40
Vaccine	Dses	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00
Medicine	Head	0.00	4.26	0.00	0.00	0.00	30.00	0.00	0.00
Dip	l	0.00	130.22	0.00	0.00	0.00	0.00	0.00	0.00
Botulinus	Dses	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00
Splenic fever	Dses	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00
Brucella	Dses	0.42	0.00	0.00	0.00	0.00	0.00	0.00	136.00
Deadline	l	79.02	0.00	0.00	0.00	0.00	0.00	0.00	100.94
Terramycin	ml	1,238.86	0.00	0.00	0.00	0.00	0.00	0.00	343.00
Black quarter	Dses	0.00	0.00	0.00	0.23	0.00	0.00	0.00	228.00
Curatic	ml	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
Antrax	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	342.00
Botulism	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	285.00
Pastorella	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	114.00
Enzoitic abortion	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	342.00
Vibriose	Dses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	570.00
Valbazen	Dses	102.21	0.00	0.00	0.00	0.00	0.00	0.00	157.86
Replace bull	Head	0.00	4,000.00	0.00	4,000.00	0.00	0.00	0.00	3,500.00
Ear plates		0.00	0.00	0.00	0.00	0.00	0.00	1.90	
Contract/hire services:									
Contract transport	ha	16.97	45.00	0.00	6.50	0.00	23.96	0.00	9.54
Machinery:									
Diesel	l	1.54	1.54	0.00	1.54	0.00	1.54	0.00	1.54
Petrol	l	1.78	1.78	0.00	1.78	0.00	1.78	0.00	1.78
Implements	hours	0.00	0.54	0.00	0.00	0.00	0.00	0.00	0.00

Table D1.2: Costs and Prices for Beef Cattle (Rand/ha), continued

	Units/ha	Zone 1 Com-mercial	Zone 3 Com-mercial	Zone 3 Small scale	Zone 4 Com-mercial	Zone 4 Small scale	Zone 5 Com-mercial	Zone 5 Small scale	Zone 6 Com-mercial
Fixed cost: Machinery									
Insurance	t	0.00	60.61	0.00	60.61	0.00	0.00	0.00	0.00
Labor:									
Livestock	hour	1.44	1.44	0.00	10.00	0.00	2.81	0.00	1.25
Machinery	hour	0.00	1.70	0.00	1.70	0.00	4.50	0.00	0.00
Additional labor	hour	0.00	0.00	0.00	0.90	0.00	0.00	0.00	700.00
Interest on operating capital	Rand	0.15	0.15	0.10	0.15	0.10	0.15	0.10	0.15

Table D1.3: Market Prices for Beef Cattle (Rand/ha)

	Units/ha	Zone 1 Com-mercial	Zone 3 Com-mercial	Zone 3 Small scale	Zone 4 Com-mercial	Zone 4 Small scale	Zone 5 Com-mercial	Zone 5 Small scale	Zone 6 Com-mercial
Gross returns :		83.10	96.29	55.24	37.94	21.39	189.42	103.09	43.54
Total receipts	Rand	83.10	96.29	55.24	37.94	21.39	189.42	103.09	43.54
Purchased inputs:									
Fattening ration	Rand	0.80	3.95	0.00	0.00	0.00	66.03	0.00	0.00
Licks	Rand	4.94	5.64	0.00	0.00	0.00	20.29	0.00	13.95
Salt	Rand	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00
P12 Phosphate	Rand	0.24	0.00	0.00	1.13	0.00	0.00	0.00	0.00
Ureum	Rand	1.03	0.00	0.00	0.15	0.00	0.00	0.00	0.00
Vitamin complex	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Small scale variable costs	Rand	0.00	0.00	6.24	0.00	0.96	0.00	56.11	0.00
Vaccine	Rand	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Medicine	Rand	0.00	0.55	0.00	0.00	0.00	8.23	0.00	0.00
Dip	Rand	0.00	1.46	0.00	0.00	0.00	0.00	0.00	0.00
Botulinus	Rand	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Splenic fever	Rand	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Brucella	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Deadline	Rand	0.49	0.00	0.00	0.00	0.00	0.00	0.00	2.52
Terramycin	Rand	8.83	0.00	0.00	0.00	0.00	0.00	0.00	0.16
Black quarter	Rand	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.16
Curatic	Rand	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
Antrax	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Botulism	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Pastorella	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Enzoitic abortion	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Vibriose	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
Valbazen	Rand	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.39
Small scale variable costs	Rand	0.00	0.00	1.33	0.00	0.08	0.00	5.35	0.00
Replace bull	Rand	0.00	4.00	0.00	0.94	0.00	0.00	0.00	1.67
Ear plates	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Contract/hire services:									
Contract transport	Rand	1.39	3.68	3.68	1.43	1.43	4.17	4.17	0.52

Table D1.3: Market Prices for Beef Cattle (Rand/ha)

	Units/ha	Zone 1 Com-mercial	Zone 3 Com-mercial	Zone 3 Small scale	Zone 4 Com-mercial	Zone 4 Small scale	Zone 5 Com-mercial	Zone 5 Small scale	Zone 6 Com-mercial
Machinery:									
Diesel	Rand	0.00	0.09	0.00	2.30	0.00	0.00	0.00	1.73
Petrol	Rand	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.06
Implements	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repairs	Rand	0.00	0.07	0.00	3.01	0.00	0.00	0.00	1.35
Fixed cost: Machinery									
Tractor/Lorrie	Rand	0.00	0.05	0.00	4.16	0.00	0.00	0.00	0.10
Interest	Rand	0.00	0.08	0.00	3.01	0.00	0.00	0.00	0.16
Insurance	Rand	0.00	0.83	0.00	0.35	0.00	0.00	0.00	0.00
Labor:									
Livestock	Rand	2.71	4.13	3.64	1.01	0.89	11.99	10.55	3.14
Machinery	Rand	0.00	0.02	0.00	1.00	0.00	19.20	0.00	0.00
Additional labor	Rand	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
Interest on operating capital	Rand	0.32	0.75	0.49	0.39	0.26	0.34	0.22	1.08
Total cost	Rand	21.64	25.34	15.37	20.23	3.61	130.25	76.40	27.45
Net returns to land and water	Rand	61.46	70.94	39.87	17.71	17.78	59.17	26.69	16.09

Table D1.4: Economic Prices for Beef Cattle (No Shadow Exchange Rate) (Rand/ha)

	Units/ha	Zone 1 Com-mercial	Zone 3 Com-mercial	Zone 3 Small scale	Zone 4 Com-mercial	Zone 4 Small scale	Zone 5 Com-mercial	Zone 5 Small scale	Zone 6 Com-mercial
Gross returns :		96.66	100.22	57.42	39.60	22.31	193.82	105.54	45.48
Total receipts	Rand	96.66	100.22	57.42	39.60	22.31	193.82	105.54	45.48
Purchased inputs									
Fattening ration	Rand	0.80	3.95	0.00	0.00	0.00	66.03	0.00	0.00
Licks	Rand	4.94	5.64	0.00	0.00	0.00	20.29	0.00	13.95
Salt	Rand	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00
P12 Phosphate	Rand	0.24	0.00	0.00	1.13	0.00	0.00	0.00	0.00
Ureum	Rand	1.03	0.00	0.00	0.15	0.00	0.00	0.00	0.00
Vitamin complex	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Small scale variable costs	Rand	0.00	0.00	6.24	0.00	0.96	0.00	56.11	0.00
Vaccine	Rand	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Medicine	Rand	0.00	0.50	0.00	0.00	0.00	7.48	0.00	0.00
Dip	Rand	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00
Botulinus	Rand	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Splenic fever	Rand	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Brucella	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Deadline	Rand	0.45	0.00	0.00	0.00	0.00	0.00	0.00	2.29
Terramycin	Rand	8.03	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Black quarter	Rand	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.15
Curatic	Rand	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
Antrax	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Botulism	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Pastorella	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Enzoitic abortion	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Vibriose	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Valbazen	Rand	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.35
Small scale variable costs	Rand	0.00	0.00	1.21	0.00	0.08	0.00	4.87	0.00
Replace bull	Rand	0.00	4.00	0.00	0.94	0.00	0.00	0.00	0.00
Ear plates	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06

Table D1.4: Economic Prices for Beef Cattle (No Shadow Exchange Rate) (Rand/ha), continued

	Units/ha	Zone 1 Com-mercial	Zone 3 Com-mercial	Zone 3 Small scale	Zone 4 Com-mercial	Zone 4 Small scale	Zone 5 Com-mercial	Zone 5 Small scale	Zone 6 Com-mercial
Contract/hire services:									
Contract transport	Rand	1.39	3.68	3.68	1.43	1.43	4.17	4.17	0.52
Machinery:									
Diesel	Rand	0.00	0.06	0.00	1.54	0.00	0.00	0.00	1.16
Petrol	Rand	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.04
Implements	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repairs	Rand	0.00	0.06	0.00	2.87	0.00	0.00	0.00	1.29
Fixed cost: Machinery									
Tractor/lorrie	Rand	0.00	0.05	0.00	4.16	0.00	0.00	0.00	0.10
Interest	Rand	0.00	0.08	0.00	3.01	0.00	0.00	0.00	0.16
Hail insurance	Rand	0.00	0.83	0.00	0.35	0.00	0.00	0.00	0.00
Labor:									
Livestock	Rand	2.71	4.13	3.64	1.01	0.89	11.99	10.55	3.14
Machinery	Rand	0.00	0.02	0.00	1.00	0.00	19.20	0.00	0.00
Additional labor	Rand	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
Interest on operating capital	Rand	0.32	0.75	0.49	0.39	0.26	0.34	0.22	1.08
Total cost	Rand	20.71	25.12	15.25	18.99	3.61	129.50	75.92	24.80
Net returns to land and water	Rand	75.95	75.09	42.17	20.60	18.70	64.32	29.62	20.68

Table D1.5: Calculation of the Resource Cost Ratios for Beef Cattle

	Zone 1 Com-mercial	Zone 3 Com-mercial	Zone 3 Small scale	Zone 4 Com-mercial	Zone 4 Small scale	Zone 5 Com-mercial	Zone 5 Small scale	Zone 6 Com-mercial
Gross returns	96.66	100.22	57.42	39.60	22.31	193.82	105.54	45.48
Tradable component:								
Fixed costs	0.00	0.46	0.00	6.95	0.00	0.00	0.00	0.25
Variable machinery costs	0.00	0.09	0.00	3.42	0.00	0.00	0.00	1.72
Purchased inputs	13.11 13.16	5.95	2.11	0.83	81.65	48.78	13.81	
Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Contract services	1.32	3.49	3.49	1.36	1.36	3.96	3.96	0.49
Value added:	82.23	83.02	47.97	25.76	20.13	108.21	52.80	29.18
Cost of domestic resources:								
Labor	2.71	4.15	3.64	2.06	0.89	31.19	10.55	3.14
Capital	0.32	0.75	0.49	0.39	0.26	0.34	0.22	1.08
Component of tradables:								
Fixed costs	0.00	0.51	0.00	0.57	0.00	0.00	0.00	0.01
Variable machinery costs	0.00	0.04	0.00	1.66	0.00	0.00	0.00	0.76
Purchased inputs	3.18	2.29	1.49	0.41	0.21	12.16	12.20	3.45
Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Contract services	0.07	0.18	0.18	0.07	0.07	0.21	0.21	0.03
Land and water	75.09	75.95	75.95	75.95	75.95	75.95	75.95	75.95
Total cost of domestic resources	81.37	83.88	81.75	81.10	77.37	119.84	99.13	84.45
Resource cost ratio	0.99	1.01	1.70	3.15	3.84	1.11	1.88	2.89

Table D2.1: Technical Coefficients for Sheep Production

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-inte	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Purchased inputs:								
Salt	Bags	0.00	0.00	0.00	63.00	60.00	0.00	48.00
Bone meal	Bags	0.00	0.00	0.00	0.00	60.00	0.00	0.00
Feedlot	head	0.00	0.00	0.00	0.00	305.00	0.00	0.00
Straw	Bale	0.00	0.00	372.00	0.00	0.00	0.00	0.00
Energy lick	Head	0.00	0.00	1,635.00	0.00	0.00	0.00	0.00
Finishing	Head	0.00	0.00	315.00	0.00	0.00	0.00	0.00
Lucerne	ha	0.00	0.00	39.90	0.00	0.00	0.00	0.00
Oats grazing	ha	0.00	0.00	39.90	0.00	0.00	0.00	0.00
Maize meal	Bags	0.00	0.00	0.00	42.00	0.00	0.00	0.00
Dica phos	Bags	0.00	0.00	0.00	38.00	0.00	0.00	39.00
Kalori 3000	Bags	0.00	0.00	0.00	15.00	0.00	0.00	0.00
Urea-sheep	Bags	0.00	0.00	0.00	5.00	0.00	0.00	0.00
Voermol	Block	0.00	0.00	0.00	0.00	0.00	200.00	0.00
Ewe pellets	Bags	0.00	150.00	0.00	0.00	0.00	0.00	0.00
Sheep block	kg	2,174.89	0.00	0.00	0.00	0.00	0.00	0.00
Voermol 18	kg	8,292.68	0.00	0.00	0.00	0.00	0.00	0.00
Creep pellets	kg	983.55	0.00	0.00	0.00	0.00	0.00	0.00
Barle	kg	9,922.00	0.00	0.00	0.00	0.00	0.00	0.00
Rum: Choc. count	kg	1,159.00	0.00	0.00	0.00	0.00	0.00	0.00
Maxiwol	kg	0.00	0.00	0.00	0.00	0.00	0.00	20,193.21
Ranide	Dses	0.00	0.00	450.00	0.00	1,023.00	0.00	1,047.00
Blue tongue	Dses	2,148.00	0.00	0.00	998.00	1,232.00	1,826.00	5,574.00
Pulpy kidney	Dses	1,294.00	2,117.00	0.00	2,926.00	2,125.00	1,534.00	2,005.00
Zipdip	L	0.00	0.00	0.00	0.00	3.00	0.00	0.00
Flukiver	Dses	0.00	0.00	0.00	0.00	1,046.00	0.00	0.00
Ivomec	Dses	0.00	0.00	0.00	1,005.00	2,092.00	0.00	1,087.00
Systamex	Dses	0.00	0.00	0.00	0.00	2,158.00	0.00	3,194.00
Vaccine	Dses	0.00	0.00	375.00	0.00	0.00	0.00	0.00
Teranol	Dses	0.00	0.00	486.00	0.00	0.00	0.00	0.00
Banminth	Dses	0.00	0.00	450.00	0.00	0.00	0.00	1,059.00
Riftvalley	Dses	0.00	0.00	0.00	236.00	0.00	0.00	0.00

Table D2.1: Technical Coefficients for Sheep Production, continued

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Wesselsbron	Dses	0.00	0.00	0.00	236.00	0.00	0.00	0.00
Pasteurellla	Dses	0.00	0.00	0.00	2,003.00	0.00	1,534.00	177.00
Lintex	Dses	3.61	0.00	0.00	2,008.00	0.00	0.00	831.00
Tramisol	Dses	0.00	0.00	0.00	3,269.00	0.00	0.00	0.00
Valbezen	Dses	1.41	0.00	0.00	2,241.00	0.00	0.00	1,706.00
Ivomac	Liter	3.03	0.00	0.00	0.00	0.00	23.58	0.00
Banminth	Liter	0.00	0.00	0.00	0.00	0.00	17.15	0.00
Ranide	Liter	0.00	0.00	0.00	0.00	0.00	15.25	0.00
Valbantel	Liter	3.64	0.00	0.00	0.00	0.00	18.34	0.00
Lintex	Liter	0.00	0.00	0.00	0.00	0.00	6.31	0.00
Valbazen	Liter	0.00	0.00	0.00	0.00	0.00	6.25	0.00
Abortion	Dses	169.00	991.00	0.00	0.00	0.00	295.00	0.00
Dazzel	Liter	0.00	0.00	0.00	0.00	0.00	40.00	0.00
Siponver	Liter	0.00	31.37	0.00	0.00	0.00	0.00	0.00
PAB	Liter	12.00	50.00	0.00	0.00	0.00	0.00	0.00
Econodip	Liter	6.00	0.00	0.00	0.00	0.00	0.00	0.00
Healing oil	Liter	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Eye powder	kg	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Antibiotics	Liter	0.35	0.00	0.00	0.00	0.00	0.00	0.00
Seponver	Liter	5.49	0.00	0.00	0.00	0.00	0.00	0.00
Miscelaneous		0.00	1,168.00	0.00	0.00	0.00	1,611.00	0.00
Wool bags	bags	12.00	0.00	0.00	9.00	4.00	67.00	43.00
Rams	Head	0.00	7.00	6.00	8.00	8.00	6.00	3.00
Vet costs	Visit	0.00	0.00	1.35	0.00	0.00	2.00	0.00
Contract/hire services:								
Contract	ha	368.40	1,000.00	0.00	900.00	757.00	500.00	737.00
Machinery:								
Diesel	l	0.00	0.00	722.52	0.00	0.00	0.00	0.00
Petrol	l	98.00	680.00	0.00	1,341.00	670.50	680.00	200.00
Labor:								
Shear	hour	676.00	0.00	262.00	1,234.00	1,040.00	1,715.00	23.42

Table D2.1: Technical Coefficients for Sheep Production, continued

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Machinery	hour	33.60	190.00	79.26	360.00	180.00	190.00	250.00
Livestock	hour	0.00	2,880.00	0.00	5,760.00	3,840.00	0.00	8,448.00
Casual	hour	676.00	0.00	36.00	0.00	0.00	0.00	0.00
Interest on operating capital	Rand	10,808.00	5,338.61	1,154.10	10,831.48	8,464.88	9,000.00	10,000.00

Table D2.2: Costs and Prices of Sheep Production (Rand/unit)

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Purchased inputs:								
Salt	Bags	0.00	0.00	0.00	8.55	8.55	0.00	8.55
Bone meal	Bags	0.00	0.00	0.00	0.00	49.04	0.00	0.00
Feedlot	head	0.00	0.00	0.00	0.00	22.10	0.00	0.00
Straw	Bale	0.00	0.00	3.40	0.00	0.00	0.00	0.00
Energy lick	Head	0.00	0.00	0.96	0.00	0.00	0.00	0.00
Finishing	Head	0.00	0.00	0.54	0.00	0.00	0.00	0.00
Lucerne	ha	0.00	0.00	40.49	0.00	0.00	0.00	0.00
Oats grazing	ha	0.00	0.00	213.69	0.00	0.00	0.00	0.00
Maize meal	Bags	0.00	0.00	0.00	36.28	0.00	0.00	0.00
Dica phos	Bags	0.00	0.00	0.00	47.14	0.00	0.00	47.14
Kalori 3000	Bags	0.00	0.00	0.00	25.41	0.00	0.00	0.00
Urea-sheep	Bags	0.00	0.00	0.00	49.87	0.00	0.00	0.00
Voermol	Block	0.00	0.00	0.00	0.00	0.00	23.83	0.00
Ewe pellet	Bags	0.00	36.10	0.00	0.00	0.00	0.00	0.00
Sheep block	kg	1.17	0.00	0.00	0.00	0.00	0.00	0.00
Voermol 18	kg	0.99	0.00	0.00	0.00	0.00	0.00	0.00
Creep pelllets	kg	1.35	0.00	0.00	0.00	0.00	0.00	0.00
Barle	kg	0.60	0.00	0.00	0.00	0.00	0.00	0.00
Rum: Choc.cont	kg	1.62	0.00	0.00	0.00	0.00	0.00	0.00
Maxiwol	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.93
Ranide	Dses	0.00	0.00	0.50	0.00	0.50	0.00	0.75
Blue tongue	Dses	0.09	0.00	0.00	0.28	0.28	0.25	0.25
Pulpy kidney	Dses	0.10	0.39	0.00	0.34	0.34	0.37	0.18
Zipdip	L	0.00	0.00	0.00	0.00	124.92	0.00	0.00
Flukiver	Dses	0.00	0.00	0.00	0.00	1.06	0.00	0.00
Ivomec	Dses	0.00	0.00	0.00	1.54	1.54	0.00	2.07
Systamex	Dses	0.00	0.00	0.00	0.00	0.98	0.00	1.22
Vaccine	Dses	0.00	0.00	0.35	0.00	0.00	0.00	0.00

Table D2.2: Costs and Prices of Sheep Production (Rand/unit), continued

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Teranol	Dses	0.00	0.00	1.67	0.00	0.00	0.00	0.00
Banminth	Dses	0.00	0.00	0.28	0.00	0.00	0.00	0.52
Riftvalley	Dses	0.00	0.00	0.00	0.85	0.00	0.00	0.00
Wesselsbron	Dses	0.00	0.00	0.00	0.20	0.00	0.00	0.00
Pasteurella	Dses	0.00	0.00	0.00	0.24	0.00	0.13	0.23
Lintex	Dses	0.00	0.00	0.00	1.37	0.00	0.00	1.46
Tramisol	Dses	0.00	0.00	0.00	0.11	0.00	0.00	0.00
Valbazen	Dses	0.00	0.00	0.00	0.54	0.00	0.00	0.24
Ivomac	Liter	1,238.86	0.00	0.00	0.00	0.00	73.32	0.00
Banminth	Liter	0.00	0.00	0.00	0.00	0.00	32.05	0.00
Ranide	Liter	0.00	0.00	0.00	0.00	0.00	33.75	0.00
Valbantel	Liter	96.56	0.00	0.00	0.00	0.00	88.30	0.00
Lintex	Liter	169.60	0.00	0.00	0.00	0.00	135.31	0.00
Valbazen	Liter	64.15	0.00	0.00	0.00	0.00	44.86	0.00
Abortion	Dses	0.32	0.29	0.00	0.00	0.00	0.30	0.00
Dazzel	Liter	0.00	0.00	0.00	0.00	0.00	30.93	0.00
Siponver	Liter	0.00	56.73	0.00	0.00	0.00	0.00	0.00
PAB	Liter	6.79	9.29	0.00	0.00	0.00	0.00	0.00
Econodip	Liter	31.44	0.00	0.00	0.00	0.00	0.00	0.00
Healing oil	Liter	18.83	0.00	0.00	0.00	0.00	0.00	0.00
Eye powder	kg	184.58	0.00	0.00	0.00	0.00	0.00	0.00
Antibiotic	Liter	174.70	0.00	0.00	0.00	0.00	0.00	0.00
Seponver	Liter	102.38	0.00	0.00	0.00	0.00	0.00	0.00
Miscelaneous		0.00	1.00	0.00	0.00	0.00	1.00	0.00
Wool bags	bags	21.60	13.50	0.00	15.98	15.98	13.80	25.44
Rams	Head	550.00	300.00	600.00	300.00	300.00	300.00	400.00
Vet costs	Visit	0.00	0.00	265.38	0.00	0.00	50.00	0.00
Contract/hire services:								
Contract	ha	3.50	7.00	0.00	6.50	6.50	7.00	11.23
Machinery:								
Diesel	l	1.54	1.54	1.54	1.54	1.54	1.54	1.54

Table D2.2: Costs and Prices of Sheep Production (Rand/unit), continued

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Petrol	l	1.78	1.78	1.78	1.78	1.78	1.78	1.78
Labor:								
Shear	hour	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Machinery	hour	1.70	0.00	1.70	1.70	1.70	1.70	1.70
Livestock	hour	0.00	1.44	0.00	1.44	1.44	0.00	1.44
Casual	hour	0.50	0.00	10.00	0.00	0.00	0.00	0.00
Interest on operating capital	Rand	0.10	0.15	0.15	0.15	0.15	0.15	0.15

Table D2.3: Market Prices for Sheep (Rand/ha)

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-	Zone 3 Extensive intensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Gross returns:	Rand	289.38	60.78	326.63	118.51	49.76	112.39	171.80
Total receipts	Rand	289.38	60.78	326.63	118.51	49.76	112.39	171.80
Purchased inputs:								
Salt	Rand	0.00	0.00	0.00	0.45	0.19	0.00	0.37
Bone meal	Rand	0.00	0.00	0.00	0.00	1.09	0.00	0.00
Feedlot	Rand	0.00	0.00	0.00	0.00	2.50	0.00	0.00
Straw	Rand	0.00	0.00	5.06	0.00	0.00	0.00	0.00
Energy lick	Rand	0.00	0.00	6.27	0.00	0.00	0.00	0.00
Finishing	Rand	0.00	0.00	0.68	0.00	0.00	0.00	0.00
Lucerne	Rand	0.00	0.00	6.46	0.00	0.00	0.00	0.00
Oats grazing	Rand	0.00	0.00	34.10	0.00	0.00	0.00	0.00
Maize meal	Rand	0.00	0.00	0.00	1.27	0.00	0.00	0.00
Dica phos	Rand	0.00	0.00	0.00	1.49	0.00	0.00	1.67
Kalori 3000	Rand	0.00	0.00	0.00	0.32	0.00	0.00	0.00
Urea-sheep	Rand	0.00	0.00	0.00	0.21	0.00	0.00	0.00
Voermol	Rand	0.00	0.00	0.00	0.00	0.00	2.98	0.00
Ewe pellets	Rand	0.00	1.93	0.00	0.00	0.00	0.00	0.00
Sheep block	Rand	7.27	0.00	0.00	0.00	0.00	0.00	0.00
Voermol 18	Rand	23.46	0.00	0.00	0.00	0.00	0.00	0.00
Creep pelllets	Rand	3.79	0.00	0.00	0.00	0.00	0.00	0.00
Barle	Rand	17.01	0.00	0.00	0.00	0.00	0.00	0.00
Rum: Choc. cont	Rand	5.36	0.00	0.00	0.00	0.00	0.00	0.00
Maxiwol	Rand	0.00	0.00	0.00	0.00	0.00	0.00	17.07
Ranide	Rand	0.00	0.00	0.90	0.00	0.19	0.00	0.71
Blue tongue	Rand	0.55	0.00	0.00	0.24	0.13	0.29	1.27
Pulpy kidney	Rand	0.37	0.29	0.00	0.83	0.27	0.35	0.33
Zipdip	Rand	0.00	0.00	0.00	0.00	0.14	0.00	0.00
Flukiver	Rand	0.00	0.00	0.00	0.00	0.41	0.00	0.00
Ivomec	Rand	0.00	0.00	0.00	1.29	1.19	0.00	2.05
Systamex	Rand	0.00	0.00	0.00	0.00	0.78	0.00	3.54
Vaccine	Rand	0.00	0.00	0.52	0.00	0.00	0.00	0.00

Table D2.3: Market Prices for Sheep (Rand/ha), continued

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Teranol	Rand	0.00	0.00	3.24	0.00	0.00	0.00	0.00
Banminth	Rand	0.00	0.00	0.51	0.00	0.00	0.00	0.50
Riftvalley	Rand	0.00	0.00	0.00	0.17	0.00	0.00	0.00
Wesselsbron	Rand	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Pasteurella	Rand	0.00	0.00	0.00	0.40	0.00	0.12	0.04
Lintex	Rand	0.00	0.00	0.00	2.28	0.00	0.00	1.10
Tramisol	Rand	0.00	0.00	0.00	0.30	0.00	0.00	0.00
Valbezen	Rand	0.00	0.00	0.00	1.01	0.00	0.00	0.37
Ivomac	Rand	10.72	0.00	0.00	0.00	0.00	1.08	0.00
Banminth	Rand	0.00	0.00	0.00	0.00	0.00	0.34	0.00
Ranide	Rand	0.00	0.00	0.00	0.00	0.00	0.32	0.00
Valbantel	Rand	1.00	0.00	0.00	0.00	0.00	1.01	0.00
Lintex	Rand	0.00	0.00	0.00	0.00	0.00	0.53	0.00
Valbazen	Rand	0.00	0.00	0.00	0.00	0.00	0.18	0.00
Abortion	Rand	0.15	0.10	0.00	0.00	0.00	0.06	0.00
Dazzel	Rand	0.00	0.00	0.00	0.00	0.00	0.77	0.00
Siponver	Rand	0.00	0.64	0.00	0.00	0.00	0.00	0.00
PAB	Rand	0.23	0.17	0.00	0.00	0.00	0.00	0.00
Econodip	Rand	0.54	0.00	0.00	0.00	0.00	0.00	0.00
Healing oil	Rand	0.27	0.00	0.00	0.00	0.00	0.00	0.00
Eye powder	Rand	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Antibiotic	Rand	0.17	0.00	0.00	0.00	0.00	0.00	0.00
Seponver	Rand	1.61	0.00	0.00	0.00	0.00	0.00	0.00
Miscelaneous	Rand	0.00	0.42	0.00	0.00	0.00	1.01	0.00
Wool bags	Rand	0.74	0.00	0.00	0.12	0.02	0.58	0.99
Rams	Rand	0.00	0.75	14.40	2.00	0.89	1.13	1.09
Vet costs	Rand	0.00	0.00	1.43	0.00	0.00	0.06	0.00
Contract/hire services:								
Contract	Rand	3.68	2.50	0.00	4.88	1.82	2.19	7.52
Machinery:								
Diesel	Rand	0.00	0.00	4.45	0.00	0.00	0.00	0.00

Table D2.3: Market Prices for Sheep (Rand/ha), continued

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Petrol	Rand	0.50	0.37	0.00	1.99	0.44	0.76	0.32
Implement	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repairs	Rand	0.79	1.80	5.80	4.21	1.15	3.16	4.59
Fixed cost: Machinery								
Tractor	Rand	1.34	3.09	9.32	7.21	1.99	5.40	4.55
Interest	Rand	0.70	1.62	5.11	3.79	0.93	2.84	2.73
Labor:								
Shear	Rand	1.93	0.00	1.05	1.03	0.39	1.07	0.02
Machinery	Rand	0.16	0.00	0.54	0.51	0.11	0.20	0.39
Livestock	Rand	0.00	1.48	0.00	6.91	2.05	0.00	11.06
Casual	Rand	0.97	0.00	1.44	0.00	0.00	0.00	0.00
Interest on operating capital	Rand	3.09	0.29	0.70	1.37	0.48	0.85	1.36
Total cost	Rand	86.43	15.46	102.01	44.30	17.16	27.28	63.65
Net returns to land and water	(R/ha)	202.95	45.32	224.62	74.21	32.60	85.10	108.14

Table D2.4: Economic Prices for Sheep Production (No Shadow Exchange Rate) (Rand/ha)

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Gross returns:	Rand	289.38	60.78	326.63	118.51	49.76	110.70	171.80
Total receipts	Rand	289.38	60.78	326.63	118.51	49.76	110.70	171.80
Purchased inputs:								
Salt	Rand	0.00	0.00	0.00	0.00	0.19	0.00	0.37
Bone meal	Rand	0.00	0.00	0.00	0.00	1.09	0.00	0.00
Feedlot	Rand	0.00	0.00	0.00	0.00	2.50	0.00	0.00
Straw	Rand	0.00	0.00	5.06	0.00	0.00	0.00	0.00
Energy lick	Rand	0.00	0.00	6.27	0.00	0.00	0.00	0.00
Finishing	Rand	0.00	0.00	0.68	0.00	0.00	0.00	0.00
Lucerne	Rand	0.00	0.00	6.46	0.00	0.00	0.00	0.00
Oats grazing	Rand	0.00	0.00	34.10	0.00	0.00	0.00	0.00
Maize meal	Rand	0.00	0.00	0.00	1.27	0.00	0.00	0.00
Dica phos	Rand	0.00	0.00	0.00	1.49	0.00	0.00	1.67
Kalori 3000	Rand	0.00	0.00	0.00	0.32	0.00	0.00	0 00
Urea-sheep	Rand	0.00	0.00	0.00	0.21	0.00	0.00	0.00
Voermol	Rand	0.00	0.00	0.00	0.00	0.00	2.98	0.00
Ewe pellets	Rand	0.00	1.93	0.00	0.00	0.00	0.00	0.00
Sheep block	Rand	7.27	0.00	0.00	0.00	0.00	0.00	0.00
Voermol 18	Rand	23.46	0.00	0.00	0.00	0.00	0.00	0.00
Creep pelllets	Rand	3.79	0.00	0.00	0.00	0.00	0.00	0.00
Barle	Rand	17.01	0.00	0.00	0.00	0.00	0.00	0.00
Rum: Choc. cont	Rand	5.36	0.00	0.00	0.00	0.00	0.00	0.00
Maxiwol	Rand	0.00	0.00	0.00	0.00	0.00	0.00	17.07
Ranide	Rand	0.00	0.00	0.82	0.00	0.17	0.00	0.65
Blue tongue	Rand	0.50	0.00	0.00	0.22	0.12	0.26	1.15
Pulpy kidney	Rand	0.34	0.27	0.00	0.75	0.24	0.32	0.30
Zipdip	Rand	0.00	0.00	0.00	0.00	0.13	0.00	0.00
Flukiver	Rand	0.00	0.00	0.00	0.00	0.38	0.00	0.00
Ivomec	Rand	0.00	0.00	0.00	1.17	1.08	0.00	1.86
Systamex	Rand	0.00	0.00	0.00	0.00	0.71	0.00	3.22

Table D2.4: Economic Prices for Sheep Production (No Shadow Exchange Rate) (Rand/ha), continued

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Vaccine	Rand	0.00	0.00	0.48	0.00	0.00	0.00	0.00
Teranol	Rand	0.00	0.00	2.95	0.00	0.00	0.00	0.00
Banminth	Rand	0.00	0.00	0.47	0.00	0.00	0.00	0.46
Riftvalley	Rand	0.00	0.00	0.00	0.15	0.00	0.00	0.00
Wesselsbron	Rand	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Pasteurella	Rand	0.00	0.00	0.00	0.36	0.00	0.11	0.03
Lintex	Rand	0.00	0.00	0.00	2.08	0.00	0.00	1.00
Tramisol	Rand	0.00	0.00	0.00	0.27	0.00	0.00	0.00
Valbezen	Rand	0.00	0.00	0.00	0.92	0.00	0.00	0.34
Ivomac	Rand	9.75	0.00	0.00	0.00	0.00	0.98	0.00
Banminth	Rand	0.00	0.00	0.00	0.00	0.00	0.31	0.00
Ranide	Rand	0.00	0.00	0.00	0.00	0.00	0.29	0.00
Valbantel	Rand	0.91	0.00	0.00	0.00	0.00	0.92	0.00
Lintex	Rand	0.00	0.00	0.00	0.00	0.00	0.49	0.00
Valbazen	Rand	0.00	0.00	0.00	0.00	0.00	0.16	0.00
Abortion	Rand	0.14	0.09	0.00	0.00	0.00	0.05	0.00
Dazzel	Rand	0.00	0.00	0.00	0.00	0.00	0.70	0.00
Siponver	Rand	0.00	0.58	0.00	0.00	0.00	0.00	0.00
PAB	Rand	0.21	0.15	0.00	0.00	0.00	0.00	0.00
Econodip	Rand	0.49	0.00	0.00	0.00	0.00	0.00	0.00
Healing oil	Rand	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Eye powder	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antibiotic	Rand	0.16	0.00	0.00	0.00	0.00	0.00	0.00
Seponver	Rand	1.46	0.00	0.00	0.00	0.00	0.00	0.00
Miscelaneous	Rand	0.00	0.38	0.00	0.00	0.00	0.92	0.00
Wool bags	Rand	0.74	0.00	0.00	0.00	0.02	0.58	0.99
Rams	Rand	0.00	0.75	14.40	2.00	0.89	1.13	1.09
Vet costs	Rand	0.00	0.00	1.43	0.00	0.00	0.06	0.00
Contract/hire services:								
Contract	Rand	3.68	2.50	0.00	4.88	1.82	2.19	7.52

Table D2.4: Economic Prices for Sheep Production (No Shadow Exchange Rate) (Rand/ha), continued

	Units/ha	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-intensive	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Machinery:								
Diesel	Rand	0.00	0.00	2.98	0.00	0.00	0.00	0.00
Petrol	Rand	0.29	0.25	0.00	1.33	0.30	0.51	0.19
Implement	Rand	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repairs	Rand	0.76	1.72	5.52	4.01	1.10	3.01	4.37
Fixed cost: Machinery								
Tractor	Rand	0.73	0.89	5.13	2.08	1.10	1.56	2.27
Interest	Rand	0.39	1.70	2.81	3.96	0.51	2.97	4.32
Labor:								
Shear	Rand	1.93	0.00	1.05	1.03	0.39	1.07	0.02
Machinery	Rand	0.16	0.00	0.54	0.51	0.11	0.20	0.39
Livestock	Rand	0.00	1.48	0.00	6.91	2.05	0.00	11.06
Casual	Rand	0.97	0.00	1.44	0.00	0.00	0.00	0.00
Interest on operating capital	Rand	3.09	0.29	0.70	1.37	0.48	0.85	1.36
Total cost	Rand	83.84	12.98	93.30	37.34	15.36	22.62	61.72
Net returns to land and water	Rand	205.53	47.79	233.33	81.18	34.39	88.07	110.08

Table D2.5: Calculation of the Resource Cost Ratios for Sheep Production

	Zone 1 Extensive	Zone 2 Extensive	Zone 3 Semi-inte	Zone 3 Extensive	Zone 4 Extensive	Zone 5 Extensive	Zone 6 Extensive
Gross returns	289.38	60.78	326.63	118.51	49.76	110.70	171.80
Tradable component:							
Fixed costs	1.07	2.46	7.54	5.74	1.53	4.31	6.27
Variable machinery costs	0.64	1.08	5.45	3.20	0.81	1.96	2.36
Purchase inputs	57.55	2.76	45.83	7.40	5.33	7.41	23.43
Transport	0.00	0.45	9.50	1.20	0.53	0.71	0.65
Contract services	3.50	2.38	0.00	4.63	1.73	2.08	7.15
Value added	226.63	51.65	258.31	96.33	39.83	94.23	131.94
Cost of domestic resources:							
Labor	3.06	1.48	3.03	8.45	2.55	1.27	11.47
Capital	3.09	0.29	0.70	1.37	0.48	0.85	1.36
Component of tradables:							
Fixed costs	0.06	0.13	0.40	0.30	0.08	0.23	0.33
Variable machinery costs	0.41	0.88	3.06	2.14	0.58	1.55	2.21
Purchase inputs	14.30	0.64	11.46	1.85	1.30	1.67	5.69
Transport	0.00	0.30	6.33	0.80	0.36	0.47	0.44
Contract services	0.18	0.13	0.00	0.24	0.09	0.11	0.38
Land and water	110.08	205.53	110.08	205.53	205.53	205.53	205.53
Total cost of domestice resources	131.17	209.39	135.05	220.69	210.97	211.69	227.40
Resource cost ratio	0.58	4.05	0.52	2.29	5.30	2.25	1.72